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## TAXONOMICAL REVISIONS



REPUBLIK INDONESIA  
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LEMBAGA ILMU PENGETAHUAN INDONESIA (L.I.P.I.)  
INDONESIAN INSTITUTE OF SCIENCES

# FLORA MALESIANA

BEING

*AN ILLUSTRATED SYSTEMATIC ACCOUNT OF THE MALESIAN FLORA /  
INCLUDING KEYS FOR DETERMINATION / DIAGNOSTIC DESCRIPTIONS /  
REFERENCES TO THE LITERATURE / SYNONYMY / AND DISTRIBUTION /  
AND NOTES ON THE ECOLOGY OF  
ITS WILD AND COMMONLY CULTIVATED PLANTS*

PUBLISHED

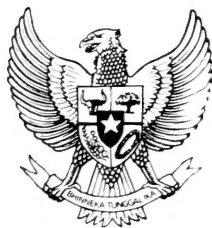
UNDER THE AUSPICES OF LEMBAGA BIOLOGI NASIONAL  
BOTANIC GARDENS OF INDONESIA / BOGOR / JAVA AND  
OF THE RIJKSHERBARIUM / LEYDEN / NETHERLANDS

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AND VARIOUS PROMINENT BOTANISTS

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BOTANICAL SCIENCE AND THE CULTURAL ADVANCEMENT OF  
THE PEOPLES OF SOUTH-EASTERN ASIA TO  
THE SOUTHWEST PACIFIC REGION

SERIES II  
PTERIDOPHYTA



VOLUME 1

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& Dr R. E. HOLTTUM

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*Dedicated to the memory of*  
**C. F. A. CHRISTENSEN**

## DEDICATION

CARL FREDRICK ALBERT CHRISTENSEN (1872–1942) was the founder of modern fern taxonomy. To appreciate the scope of his work, it is necessary to understand the confusions of thought on the subject which persisted through the 19th century and were still evident in the summary prepared (by DIELS) for ENGLER & PRANTL's *Pflanzenfamilien* in 1899. CHRISTENSEN's first great work was his *Index Filicum* (1905–6) in which he listed all known fern binomials and also relegated many to synonymy. In the main he adopted the classification and nomenclature of DIELS. While preparing the Index he came to realize that many generic concepts accepted in the Index were unnatural or confused. This was especially evident in the great complex of species which he listed under the name *Dryopteris*. He next made a study of the tropical American species of that complex, and in so doing discovered how to separate them into natural groups (1913, 1920). At the time I first made contact with him (about 1925) he had begun to study ferns of the Old World tropics. I maintained a regular correspondence with him from 1925 to 1940, and sent him many specimens for identification. I also met him in Europe in 1930, 1934 and 1938 and had long discussions with him. I benefited from his wisdom also indirectly through the publications of R. C. CHING, who studied with CHRISTENSEN in 1929–1932 and applied CHRISTENSEN's ideas to Chinese and Indian ferns in an important series of papers in the 1930s. CHRISTENSEN's identifications of my collections and his comments upon them were the basis on which my own work was built; in the present Series of Flora Malesiana I have tried to extend his methods and his ideas to a much wider range of species than he could have encountered. To him I am profoundly grateful, and I am concerned also to acknowledge my debt, through him, to some perceptive earlier workers, notably G. H. METTENIUS and JOHN SMITH.

The objectives of any scheme of biological classification are to show natural relationships and to provide a means for the identification of individual organisms. It has sometimes been suggested that only the latter objective is important, and that a 'practical' scheme is all that is needed. The history of fern classification has shown that artificial schemes, made without thought as to relationships, do not work; and distribution-maps based on such schemes are meaningless. Fern classification as understood today should be based not only on gross-morphological characters but also on microscopical characters pertaining to the fern's anatomy, indument, spores, gametophytes, etc., and on cytotaxonomy.

There can be no doubt that existing ferns have originated through a process of evolution. They have therefore an inbuilt classification, and our object is to find it; the nearer we get to it, the nearer we are to the practical aspect of taxonomy. Fossils provide no clear evidence of the progress of the evolution of the great majority of leptosporangiate ferns. In most cases our only evidence for this is the natural relationships shown by taxonomy. We now have reached the stage at which most Malesian species can be allocated to definable natural groups which may have generic rank; most genera can also be associated in groups which appear to be natural; but it is often not yet clear how groups of genera are inter-related. For example, within the family *Thelypteridaceae* I cannot see a definite pattern of inter-relationships between the groups of genera which I have recognized. For a better understanding of this wider problem, genera throughout the tropics need to be taken into consideration; such an undertaking is beyond the scope of Flora Malesiana Series II, but I believe that this Series has presented a great deal of new evidence on which wider considerations may be based.

Some botanists appear to think that a Flora is not the place for discussion of such questions. I disagree with that idea. Floras and taxonomic monographs always appear to account for everything, owing to the nature of their presentation. But in fact there are always gaps and uncertainties, especially in tropical Floras; some indication of this should be given; no classification can be final.

Even within groups of ferns already dealt with in Flora Malesiana, much more information is needed. For example, existing specimens do not show clearly the distinctions between species in the genus *Plesioneuron* (*Thelypteridaceae*). There is a great need for new collections made by persons who have specialist knowledge and are prepared to undertake prolonged critical search. After the publication of my book on the ferns of Malaya, BETTY MOLESWORTH ALLEN, by persistent collecting, discovered nearly twenty additional species including representatives of three additional genera.

The genera of LINNAEUS, which should be the basis of fern classification, are very crudely defined, and are only useful through agreement as to their typification. He did not notice indusia, upon which J. E. SMITH (1793) was the first to base new generic concepts, but SMITH also was not a critical observer. Within a few years, several other authors extended his observations and proposed new generic names, some not well distinguished, and in 1801 SWARTZ and BERNHARDI noted (more exactly than SMITH) the differences between annulate (or gyrate) and exannulate sporangia. These observations were collated by SWARTZ in his *Synopsis Filicum* (1806) where he separated the genera of *Osmundaceae*, *Schizaeaceae* and *Gleicheniaceae* as spuriously gyrate, distinguishing the annulate genera (*Polypodiaceae*) solely by the form of indusia and the form and position of sori where indusia were lacking. An extreme example of the artificial nature of some genera proposed at this period is *Belvisia* MIRBEL (1802) which, in addition to the recognized type *B. spicata* (L.) MIRBEL (*Polypodiaceae*) included species now allocated to *Actiniopteris*, *Schizaea*, *Asplenium* and *Ceratopteris*.

Simultaneous with SWARTZ, SCHKUHR was producing the first good series of illustrations of ferns (1804–1809). When one makes a drawing of a plant with the intention of accuracy, one often notices hitherto neglected characters. This was true of SCHKUHR, who observed and commented upon many details, especially of hairs, which have, since CHRISTENSEN, become recognized as important key characters. He noticed the jointed (septate) hairs of *Ctenitis villosa* (L.) COPEL., and portrayed accurately the equally long unicellular hairs on the indusia of a species of *Christella*, though he did not comment on the latter. In some cases he illustrated venation clearly and accurately, in others indistinctly or casually. Some of SCHKUHR's drawings were made from living plants, but most were from dried specimens.

HOOKE and GREVILLE's *Icones Filicum* (1827–1831) was the next illustrated work. The plates were better executed (by GREVILLE) than SCHKUHR's and one can also detect a gradual increase of interest in detail as the series progressed. For example, plate 5 depicts *Ceterach pedunculatum* and plate 6 *Grammitis decurrens*, but in neither case are any details of venation shown; both species are now placed in the genus *Colysis* PRESL (*Polypodiaceae*). Plate 125 shows *Polypodium irioides*, with enlarged details of venation well observed. Simultaneous with HOOKE and GREVILLE, BLUME (1829–1830) was publishing the wonderful plates 1–65 of his *Flora Javae, Filices*, in which details are, on the whole, even more carefully dealt with. His subdivision of *Polypodium* is important.

H. SCHOTT, at the imperial palace of Schönbrunn, had living fern plants in his care and published (1834) a short series of excellent engravings illustrating new genera, showing much more detail than HOOKE and GREVILLE; some of these were certainly based on living plants, in particular his *Nephrodium* which shows very exactly capitate hairs and the elongate unicellular glands which are present on the stalks of sporangia, noted by no-one else until I made drawings of them in Singapore in 1943 (published 1971). Between 1840 and 1851 G. KUNZE published a series of illustrations which he regarded as a continuation of SCHKUHR's. He was in charge of the Botanic Garden at Leipzig, in which was the best collection of living ferns in Europe (soon to be surpassed by Kew). His successor at Leipzig, G. H. METTENIUS, inherited KUNZE's living collections

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and herbarium, and on their basis prepared a new system of classification of ferns (1856) with plates often showing new details. He subsequently prepared monographs describing all known species of several major genera, after which he began observations on the collections from Malesia in the Rijksherbarium. He had previously misinterpreted some of BLUME's species through not having seen authentic specimens, and corrected some of them in the *Ann. Mus. Bot. Lugd.-Bat.*; he also incorporated new basic observations on several genera. While engaged on the latter work, he died of cholera in 1866 at the age of 42. Had he lived longer, he would have changed the course of pteridological thinking; I will revert to him later.

C. B. PRESL was given the task of describing the collections made by HAENKE on the Malaspina Expedition; these included many specimens of ferns from the Philippines (described in 1825). As a result PRESL became interested in the classification of ferns, and realized that characters other than those of sori needed to be taken into account. In 1836 he published *Tentamen Pteridographiae*, comprising a new scheme of classification in which the arrangements of vascular tissue, and of venation, had an important place. His work is illustrated by many small drawings showing details of venation in relation to sori, in most cases quite accurately. His later publication (1848) showing arrangement of vascular strands in the stipes of ferns is not so well observed. PRESL's emphasis on venation led him to associate together species of very diverse relationship, but it was a beginning of new thought.

At the same time JOHN SMITH of Kew had been taking an interest in the cultivated tropical ferns in his charge, many raised (as at Leipzig) from spores from herbarium specimens. He was in touch with ROBERT BROWN, who had made some original observations on the venation of ferns when describing his own Australian specimens and also some collected by HORSFIELD in Java. SMITH was also in touch with FRANCIS BAUER, the Kew botanical artist, and supplied him with living fern plants and herbarium specimens, from which BAUER prepared a beautiful set of forty plates. These were submitted to W. J. HOOKER (then at Glasgow) who arranged for them to be published and added more, prepared by W. H. FITCH, 120 plates in all, finalized after HOOKER came himself to Kew. Many of the genera are those of PRESL, but twenty were newly named and described by JOHN SMITH. SMITH himself had prepared a new scheme of classification independently of PRESL, finding much agreement between their ideas when the *Tentamen* appeared; he collated his nomenclature with PRESL's and his scheme was published by HOOKER in 1841-1843. JOHN SMITH continued to study ferns, and to add to the collection of living plants at Kew. By 1865, when he was obliged through failing sight to retire, he had seen more than 1000 species of ferns in a living condition, of which he published a list in 1866. The final summary of his ideas, resulting from continued observation of living plants, appeared in 1875 and will be considered later.

Having published *Genera Filicum*, HOOKER planned *Species Filicum*, in which he proposed to describe all known species of ferns. For this, he had to re-consider the question of classification, and concluded that PRESL had proposed too many genera; the result was that HOOKER's genera in *Species Filicum* are almost the same as those of SWARTZ. The work was published in five volumes over a period of twenty years (1844-1864); HOOKER planned to follow it with a summary in one volume, to be called *Synopsis Filicum*. He died just as the first part of the latter was printed. J. D. HOOKER, who succeeded his father at Kew, engaged J. G. BAKER to continue the *Synopsis* on the lines planned, and this was completed in 1868 (second edition, with many additions by BAKER, in 1874). In 1891 BAKER published a summary of new ferns discovered since 1874, still with the same set of genera.

HOOKER's *Species Filicum* was illustrated by 304 excellent plates prepared by W. H. FITCH (often two species on one plate). These show clearly and accurately details of venation and

indusia, but rarely any smaller structures. In his descriptions HOOKER rarely described details of hairs or scales. He thought such details unimportant; his main objective (see Vol. 3, p. 3) was 'to assist the tyro in the verification of genera and species . . . natural habit is often a safer guide than minute microscopic characters'. He placed most exindusiate species of Thelypteroid, Tectarioid and Dryopteroid ferns in the genus *Polypodium*, but some in *Gymnogramme* and *Meniscium*; *Dictyocline* was merged with *Hemionitis*. He could not understand how JOHN SMITH could believe *Brainea* to be closely related to *Blechnum*, though it differs from *Blechnum* only in the absence of indusia. He placed *Brainea* between *Gymnogramme* (which included the diverse genera *Selliguea* and *Syngamma*) and *Meniscium*. His refusal to examine details led him to include in one species specimens which show great diversity in what are now considered to be significant characters. He united most of FÉE's species of *Lomariopsis* (including also *Teratophyllum* METT.), thus including several distinct Malesian species in *Acrostichum sorbifolium* L., of which the type came from the West Indies. His confusions in the synonymy of Thelypteroid ferns are very numerous, and can only be understood by reference to his herbarium. BAKER's descriptions of ferns discovered after HOOKER's death are even less satisfactory than HOOKER's and often do not serve to identify specimens with any certainty.

The remaining authors who proposed new schemes of classification were FÉE (1852) and T. MOORE (1857). FÉE's works were all admirably illustrated and his numerous plates show many significant details, but not always accurately. For example, in tab. XXI A, fig. 2 he was the first to show a transverse section of the stipe of *Pleocnemia* (*sensu* HOLTUM 1974), but the accompanying figure of venation in an allied species (fig. 1) is not accurate and fails to show the distinctive sinus-teeth. Neither FÉE nor any earlier author (so far as I have observed) shows the distinctive row of four cells on one side of the sporangia of leptosporangiate ferns. FÉE attempted to use the number of cells in the annulus as a generic character, but this is rarely practicable. His scheme is more elaborate than PRESL's but is no nearer to a natural arrangement by present standards. He has *Phegopteris* as a genus separate from *Polypodium*, but in the same group of genera, not with its true allies, which are in other groups. Under the tribe *Acrosticheae* he has an astonishing diversity of genera.

THOMAS MOORE's scheme is accompanied by good small drawings to show diagnostic characters. For example, he shows the difference in venation between *Stenochlaena* and *Lomariopsis*, not noticed by FÉE. But his scheme only differs in minor features from that of PRESL.

MILDE in 1866 made important observations of scales and stipe-anatomy showing a clear distinction between *Asplenium* and *Athyrium* (including *Diplazium*); he elaborated these in 1870. METTENIUS had noted that previous attempts to distinguish these genera were unsatisfactory, and HOOKER denied that any clear distinction was possible (and in 1928 BOWER still copied HOOKER's statement). In my judgement (HOLTUM 1947) *Asplenium* and *Athyrium* are not very closely related.

R. H. BEDDOME did not propose a new scheme of classification, but during the years 1856–1882 he made a more intensive field study of ferns in a tropical region than any previous author. He was critical of HOOKER's genera and made some minor alterations in them for purposes of his Handbook (1883, with Supplement 1892), though still accepting the main scheme (his preface hinted that more needed changing). His work covered the Malay Peninsula and so is important for Flora Malesiana (he also accepted HOOKER's misidentification of some Indian ferns with species in Java).

JOHN SMITH's *Historia Filicum* (1875) proposed a new scheme based on much study of living plants subsequent to his first one (1841). He did not use a microscope, and rarely refers to details of structure of sporangia, scales *etc.*, but from observation of his plants he did learn much that

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HOOKE never understood. I will refer later to some of his insights in a discussion of the work of DIELS. SMITH and METTENIUS, both observers of living plants, were the only authors of their period who (apparently independently) separated *Phegopteris*, *Dictyopteris* and other terrestrial exindusiate ferns from the alliance of *Polypodium* and transferred them to one including *Aspidium*. Both authors maintained separate genera for the exindusiate ferns, but JOHN SMITH admitted that probably some species were placed in *Phegopteris* and *Dictyopteris* merely because the only known specimens had old sori from which indusia might have fallen. Presumably he still thought the idea of uniting indusiate and exindusiate species in one genus too revolutionary. It should be noted that both METTENIUS and SMITH had a mixture of Thelypteroid, Tectarioid and Dryopteroid ferns in their genera, whether indusiate or not; and SMITH kept *Meniscium* (*Thelypteridaceae*) far from his Aspidioid ferns. The major advance in thinking was that indusiate and exindusiate species could be closely allied; this was something HOOKE refused to consider.

In this connection, the history of *Pleocnemia leuzeana* (GAUD.) PRESL is instructive. GAUDICHAUD described the species (from the Moluccas) in the genus *Polypodium* because its sori were exindusiate. PRESL founded a new genus based on the combination of a particular vein-pattern with circular exindusiate sori. Later CUMING collected specimens in Luzon which were similar in venation and general aspect, but some of them had indusiate sori. HOOKE, who had illustrated the genus *Pleocnemia* as exindusiate (Gen. Fil. t. 70A, copied from PRESL) published drawings made from two of CUMING's specimens, one sterile and one showing indusiate sori (t. 97), and stated that this gave him an opportunity to correct his previous 'error' in reporting that *P. leuzeana* was exindusiate. But CUMING made four different collections (all seen by HOOKE) which are now known to represent three distinct species, two of them indusiate, one exindusiate, all different from the type specimen of *P. leuzeana*. HOOKE assumed that some specimens had lost the indusia which they originally possessed. FÉE had specimens of the same collections from CUMING, and speculated (1852, p. 311) on the strange fact that different plants of the same species could have, or lack, indusia. BEDDOME, examining plants of *Pleocnemia* from N.E. India which are in fact exindusiate (as seen from young sori) and belong to a species different from all three in the Philippines, thought that his Indian specimens must have lost their indusia and figured a fertile leaflet from a Philippine specimen (Ferns Br. India, t. 134). COPELAND in 1960 (p. 310) still only recognized one species in the Philippines, noting that the indusia are 'sometimes fugacious'. Recent collections from Mt Makiling, at the foot of which COPELAND spent several years, confirm that CUMING's three species are distinct. The fronds are very large, so that only small parts can be put on herbarium sheets, and the stipe-scales (usually absent from herbaria) are distinctive. But herbarium specimens do show enough peculiar details if one knows what to look for, and the sum of these characters is sufficient to indicate that these species (and some others) form a genus distinct from *Tectaria* (to which COPELAND referred *P. leuzeana*), though the venation-pattern of *Pleocnemia* does occur in some species of the former. The sinus-teeth, which project out of the plane of the frond and are very conspicuous in living plants, were not noted by anyone except GAUDICHAUD until I re-defined the genus (HOLTUM 1951, 1974); there are also distinctive glands (noted by METTENIUS but not by others). The petiolar vascular structure, also peculiar, was figured by FÉE (1852, t. 21A fig. 2) and mentioned by no-one else.

It was details such as the presence and nature of scales, hairs and glands on pinnae that METTENIUS noted; these have subsequently been found to be significant diagnostically, and they give METTENIUS's specific descriptions a significance that is often lacking in BAKER's. METTENIUS maintained large genera, perhaps (like CHRISTENSEN at a later time) because he did not want to publish new binomials until he was more sure of them; he subdivided his large genera much more

intelligently than HOOKER, and made improvements in subdivision in his works published in 1864. DIELS erred in ignoring several important observations made by METTENIUS.

The situation near the end of the century was that in most cases clear distinctions between groups of genera, and often even between genera now known not to be closely related, had not been discovered. This was due to a failure to understand that similar structures, whether of venation or sori, could have come into existence along different evolutionary lines. It is very clear that this is true of a simple type of anastomosis, seen in such genera as *Acrostichum* (*s.str.*), *Pteris*, *Elaphoglossum*, *Lomagramma*, *Taenitis*, *Lindsaea* and *Hemionitis*; in *Pteris*, *Lindsaea* and *Elaphoglossum* most species have free veins. The vein-pattern in *Tectaria* (*Aspidium* of Ind. Fil. 1905) and *Microsorium* (a segregate from *Polypodium*) is closely similar; in Malaya I found that up to 1955 a species of *Tectaria* had been included by all authors in *Polypodium*. It is also evident that acrostichoid ferns belong to several different alliances; and the acrostichoid condition is not exactly definable, so that authors disagreed in assigning genera to it. The sori of *Davallia* and *Microlepia* are very similar, but in other respects the plants are very different. An extreme case is *Heterogonium* PRESL, which I believe to be a natural genus (HOLTUM 1949); some species have indusia, some not; some species have free veins, some have anastomoses; some have separate indusiate sori, some are acrostichoid.

So the problem is to look for characters which may be a better guide to relationship than vein-patterns and sori. MILDE had shown the way by distinguishing between *Diplazium* and *Asplenium* on the basis of scales combined with vascular anatomy of the stipe. SMITH had noted that *Polypodiaceae* (*s.str.*) and the *Davallia* group of genera have a creeping caudex with stipes jointed to the dorsal surface of it; he coined the term *Eremobrya* for ferns of this habit; other ferns he called *Desmobrya*. The two terms were first defined in 1855. By this standard the ferns included by CHING (1940) and HOLTUM (1947) in *Grammitidaceae* are separate from *Polypodiaceae*. METTENIUS also found that the spores of the two groups differ (see below on DIELS 1899).

HERMANN CHRIST (1833–1933) was a lawyer who throughout a long life was actively interested in plants. He began to publish papers on ferns in 1890, and in 1897 produced *Die Farnkräuter der Erde*, an attempt to give a more balanced view of the more important species throughout the world than HOOKER and BAKER. He recognized the nature of the problem stated in the preceding paragraph, but did not manage to do much towards solving it. He placed *Aspidium* and *Phegopteris* (still separate genera, on the model of METTENIUS) in a family *Aspidiaceae*, distinct from *Polypodiaceae*, but under both *Aspidium* and *Phegopteris* had a great mixture of species not closely allied. In *Polypodiaceae*, tribe *Acrosticheae*, he had much confusion, especially in the genus *Stenochlaena* (see HOLTUM 1978, pp. 261, 266); some of this was copied by DIELS. His later work also showed lack of critical insight. In his monograph of *Elaphoglossum* (1899) he tried to subdivide the genus on characters of venation, but did not examine the veins carefully and the result is confusion; in his paper of 1907 on the Philippine species of *Dryopteris* (the composite genus of Ind. Fil. 1905) he did not make good descriptions nor understand relationships between species. He did not know of MILDE's work.

The century closed with the volume of ENGLER & PRANTL's *Pflanzenfamilien* covering vascular cryptogams, in which DIELS dealt with almost all the ferns (1899–1900). His *Polypodiaceae* consisted of nine tribes. He transferred several genera of the tribe *Acrosticheae* of some previous authors to *Aspidieae*, but mixed together Aspidioid and Polypodioid species under *Polybotrya*. He placed the Polypodioid genus *Platyserium* in *Acrosticheae*. He united *Phegopteris* with *Aspidium* but had a great mixture of species in it; his treatment only adds more confusion to an already very confused situation. He did understand MILDE's work, but he failed to notice some important observations made by METTENIUS and JOHN SMITH, of which the following are three examples.



## Dedication

1. *Gleicheniaceae*. PRESL based his primary division of *Gleichenia* (*sens.lat.*) on the position of the sori on the veins, stating that in *Eu-Gleichenia* the sori were terminal, in all other cases dorsal on the veins. This division was copied by HOOKER, CHRIST and DIELS; but in 1856 METTENIUS had stated that the sori are *not* terminal in *Eu-Gleichenia*, and had repeated this in 1863. In the latter paper he divided *Gleichenia* into three subgenera, stating that two of them agreed in scales and in sporangia, the third (*Dicranopteris*) differing in both these structures. This was ignored by DIELS, who did not cite the paper of 1863 and mixed together in one subgenus species of *Dicranopteris* with those which differed both in scales and in sporangia. When preparing an account of the family for Flora Malesiana (HOLTUM 1959) I failed to notice METTENIUS 1863 and repeated his observations, differing only in the recognition of *Dicranopteris* as a genus distinct from *Gleichenia*, the latter having three subgenera; this is certainly the important division.

2. *Stenochlaena* and *Lomariopsis*. In 1875 (p. 140) JOHN SMITH stated the distinctions between these two genera (he had united them in 1841 and subsequently discovered the difference through observation of living plants). METTENIUS still included them in the same genus (1869, in a posthumous paper edited by KUHN) but in separate sections, and he established a new genus *Teratophyllum*, distinct from both, with two species. DIELS united *Stenochlaena*, *Lomariopsis* and one species of *Teratophyllum* in one genus (in the tribe *Asplenieae*) which he divided into two sections: *Eu-Stenochlaena* comprising the whole of *Lomariopsis* and *Teratophyllum aculeatum* (BL.) METT., and *Cafraria*, which consisted only of *S. tenuifolia*; the latter differs from the type species *S. palustris* (BURM.) BEDD. in having bipinnate fertile fronds and in little else. This is an absurdly unnatural division. DIELS included the second species of *Teratophyllum* (*T. articulatum* (J.Sm.) METT.) in *Polybotrya* (tribe *Aspidieae*).

3. *Grammitidaceae*. This family was recognized as distinct by CHING in 1940; for fuller details see also HOLTUM 1947 and 1955. DIELS placed all species of the family in *Polypodium sect. Eu-Polypodium*, mixing them indiscriminately with true *Polypodium* species, except *Prosaptia* PRESL which he included in *Davallia*. BLUME in 1830, though retaining them in *Polypodium*, had already distinguished these ferns as 'spurious' in that genus. METTENIUS (1866) distinguished them in *Polypodium* as Div. 1, *Sphaerosporeae*, placing true *Polypodium* in Div. 2, *Nephrosporeae*; he did not mention *Prosaptia* in this paper, but had previously placed it with *Davallia*. As above noted, JOHN SMITH placed most Grammitoid ferns in his division *Desmobrya*, and thus separated them from *Polypodium*, but somehow he included *Prosaptia* (with the closely related *Cryptosorus*) in *Eremobrya*; he did however note that their sori were very different from those of *Davallia*. For some reason which is not at present understood, Grammitoid ferns are difficult to maintain in cultivation, and not one of them appears in JOHN SMITH's list of species which he had seen alive; this probably accounts for his mistake in placing *Prosaptia* with *Polypodium*. METTENIUS always noted the peculiar hairs on plants of *Grammitidaceae*, and also the hairs on scales and setae on sporangia, where these occur (true *Polypodiaceae* never have these characters). When he died in 1866 he was just beginning to see the significance of such structures.

Towards the middle of the 19th century academic botanists realized that taxonomic study, of the limited and formal kind which still prevailed, did not deal with important aspects of the life of plants. So they started 'scientific botany', but they made the mistake of thinking that taxonomy was an out-dated activity; many such botanists still persist in that mistake. What was needed was a better taxonomy, not its abandonment. This was especially true of tropical plants in general, and most ferns are tropical; significant facts about these plants had often not been put on record, or if recorded (such as the hairs figured by SCHKUHR) had not been understood. As 'scientific' botany diverged more and more from taxonomy, the shortcomings of the latter were less and less understood. A factor in this process was, and still is, the binomial system of nomenclature.

Valid names consist of two parts, a generic name and a specific epithet. Thus one must know the correct genus if one wishes to describe a new species. But in the case of tropical plants, which were very little known to earlier authors, it was impossible to be sure of generic concepts, which changed with increasing knowledge. Thus the binomial system, in theory, imposed an impossible condition for naming new species. In practice, this situation was avoided by allowing taxonomists to make the best guess they could, with permission afterwards to change the generic name if later knowledge so indicated. Morphologists rightly wished to study plant-structures not mentioned in taxonomic descriptions; taxonomists were slow to realize the need for this as a help to better taxonomy. An outstanding exception was METTENIUS, who published important works on lateral buds on ferns (1860), on the morphology and anatomy of *Angiopteris* in comparison with other ferns (1863A) and on *Hymenophyllaceae* (1864B).

Morphologists who have not a wide knowledge of taxonomy are apt to think that any species is representative of the generic name it bears, and thus are liable to have erroneous ideas about genera (especially where such genera are still not clearly defined), and may be misled into making wrong comparisons or invalid statements about phylogeny. In view of the above discussion on the history of taxonomic study of the leptosporangiate ferns, it is evident that most 19th century taxonomy was an inadequate guide to morphologists. The most important morphologists were GOEBEL and BOWER. BOWER began his studies in the 1880s, mainly on the more primitive ferns. When he came to his summary on the leptosporangiate ferns (1928) he quoted GOEBEL's comparison of their study to wandering in a dark and trackless forest, but he did not know enough about existing information which could have provided him with some guiding light. He did not know of the work of MILDE and discussed the possible evolution of the sorus of *Asplenium* by reference to a species of *Diplazium*. He discussed *Stenochlaena*, which he interpreted according to the confused statement by CHRIST, and described the anatomy of the rhizome, but the material he described belonged to a species of *Lomariopsis*, as he could have learned from JOHN SMITH. He placed *Phyllitis* in a group separate from *Asplenium*, not knowing that natural hybrids between the two existed. He accepted CHRIST's comparison of *Elaphoglossum* with *Syngamma*, though the resemblance between the two is very superficial. He accepted the idea that the sorus of *Microlepia* was marginal in phyletic origin, but did not realize that this might also be true of *Cyathea* and *Dryopteris*. He insisted that *Deparia* was a natural genus, though each of the species included in it shows an alliance to a different group of ferns. He had not looked at CHRISTENSEN's dismemberment of '*Dryopteris*' and accepted a phyletic sequence (fig. 663 on p. 132) which derives the vein-pattern of *Bolbitis* (then still included in *Leptochilus*) from the condition of a Thelypteroid fern. But he did have a better understanding of the Gymnogrammoid ferns. GOEBEL had far more understanding than BOWER, having spent at least two periods of study in Java (BOWER never went to the tropics), but he did not keep in touch with CHRISTENSEN's work.

As above noted, CHRISTENSEN made a systematic study of all the tropical American species included in the comprehensive *Dryopteris* of *Index Filicum*. In so doing he followed the example of METTENIUS in looking for details of dermal appendages, but more critically and more consistently than METTENIUS had done; he had also a much wider range of species to examine. In this process he discovered that the many species could be separated into groups according to the nature of their hairs; he rightly insisted that groups distinguished in this way show also many other differences of a less easily definable character. CHING (1936, p. 243) added the distinctive character of vascular anatomy of the stipe of Thelypteroid ferns, in which they constantly differ from *Ctenitis* and *Dryopteris* (*s.str.*), as indeed METTENIUS had noted in his discussion of *Aspidium* in 1864. CHRISTENSEN (1911) expressed the opinion that some of the groups he had distinguished should be regarded as good genera, but he retained them in *Dryopteris* because he wished to

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examine species of the Old World before publishing new combinations. This work of CHRISTENSEN's was a turning-point in fern taxonomy. R. C. CHING applied CHRISTENSEN's ideas to ferns of southeast Asia, clearing up much previous confusion. But *Thelypteridaceae* are far more abundant and more diversified in Malesia than in mainland Asia. When writing my book on the ferns of Malaya (1955) I adopted CHING's generic concepts but stated (p. 236) that the resulting arrangement was not a natural one. I made new observations, especially of glands and hairs on sporangia (some not then published) but could not see my way to a good re-arrangement on the basis of the limited number of species in Malaya. It was only when I looked at all species in Malesia, mainland Asia and the Pacific (and also many previously unnamed collections), noting in detail structures not mentioned in earlier descriptions, that I was able to see how to improve on CHING's scheme, and to establish new genera peculiar to the Old World. CHING's work and mine (presented in the present volume) are built on CHRISTENSEN's methods and on his insights.

CHRISTENSEN subsequently identified a number of collections of ferns from Malesia and Asia (including my Kinabalu ferns, 1934) and wrote a fern flora of Madagascar (1932); in so doing he examined a large number of type specimens which had not been well described and published new information about them. The nomenclature in my book of 1955 was largely dependent on his observations on types. In 1939 he contributed a chapter on the classification of ferns to VERDOORN's *Manual of Pteridology*. This contains many new ideas, the result of his wide-ranging studies; from it one can judge the progress made since 1905, largely due to his own work and thought. His last work was a fern flora of Samoa, published after his death (1943). Owing to the stress of the war situation, no adequate obituary notice was published.

*Pteridology in Malesia.* The first considerable field work was on the ferns of Java, summarized by BLUME in 1828 and elaborated with excellent illustrations in 1829–30 (additional plates were published in 1847 and 1851). Little more was published until RACIBORSKI went to Bogor and undertook new field studies in West Java, summarized in his book of 1898; his descriptions are better than most of their time and his ecological information is valuable. A few years later, VAN ALDERWERELT VAN ROSENBURGH began fern studies covering the whole of Malesia by collating all existing descriptions, most of them too brief or too inaccurate to form a good basis for the keys which he prepared. In the main he followed the nomenclature of *Index Filicum*, but he wanted more clear-cut distinctions between genera as a better guide to identification, and so he adopted an artificial system. He reverted to a comprehensive tribe *Acrosticheae*, and a tribe *Phegopterideae* widely separated from *Aspidieae*; he revived *Pleocnemia* PRESL and included in it some Thelypteroid ferns. After completing his *Handbook* (1908) he continued a critical study of the specimens in the herbarium at Bogor, including many new collections, also plants in cultivation. He published descriptions of these in a series of papers, those up to 1917 being summarized in his *Supplement*. These new and amplified descriptions show a careful examination of much detail not previously recorded, including observations on spores; many of his new species are still recognized in the present work.

In Malaya H. N. RIDLEY made large new collections in the years 1888–1911, but his published work on them (1926) is very uncritical; his generic and specific descriptions are confused and sometimes inaccurate; the names he wrote on herbarium specimens at Kew are often wrong. Thus his statements on distribution of species are also often wrong. It is sometimes impossible to know the basis of such statements because often he did not write names on herbarium sheets in Singapore; I re-arranged the sheets without noting in which covers RIDLEY had placed them. RIDLEY's work on ferns is therefore usually ignored in *Flora Malesiana* except for his new names.

E. B. COPELAND (1873–1964) began a study of ferns in 1893 but soon specialized in plant

physiology. He went to the Philippines in 1903 and during the years to 1917 made extensive field studies of ferns, also naming and describing collections made by others from the Philippines and other parts of Malesia. Between 1917 and 1928 he was concerned with rice cultivation in California; after that most of his active life was devoted to ferns. I have elsewhere (HOLTUM 1973) summarized his work, which culminated in his *Genera Filicum* (1947). His observations on Philippine ferns, based on the same classification, were not published until 1960. He was the first person to understand that HOOKER's genera *Cyathea*, *Hemitelia* and *Alsophila* were unnatural, but his revised scheme for *Cyatheaceae* in 1947 was little better because he did not examine the detailed structure of scales. Similarly, in dealing with *Thelypteridaceae* (which he did not recognize as a distinct family) he did not look carefully at hairs and glands; his descriptions of species are little better than BAKER's. His floristic work suffered also because he did not see the types of many of the older species and misconstrued some of them; this however does not excuse his failure to distinguish between *Sphaerostephanos penniger* (HOOK.) HOLTUM and *Pneumatopteris truncata* (POIR.) HOLTUM (as named in the present work). Yet in *Hymenophyllaceae* he did make very careful detailed observations of structure, which were very fully illustrated (COPELAND 1933, 1937, 1938). His families *Pteridaceae* and *Aspidiaceae* of 1947 are both confused mixtures which are still not fully disentangled. In general, COPELAND's failure was due to not looking for significant characters. His statement that the generic separation of *Gymnocarpium dryopteris* NEWM. from *Phegopteris connectilis* (MICHX) WATT was hardly possible is an illustration of this.

Simultaneously with COPELAND's work in the Philippines, C. A. BACKER (from 1905) was making large collections of ferns, as part of his general herbarium of the flora of Java. He collaborated with O. POSTHUMUS, who had specialized on ferns and had made many collections in several other islands also, in the production of a fern flora of Java (1939). The nomenclature follows that of the third supplement of *Index Filicum*. In general, this is a considerable advance on VAN ALDERWERELT, though the descriptions of species in complex genera are not as good as VAN ALDERWERELT's later ones. In *Cyatheaceae* the genera are not well distinguished and the specific descriptions are very inadequate; the authors could have learned much from METTENIUS (1863B). In *Dryopteris* no attempt is made to separate Thelypteroid species from the rest. The Grammitoid ferns are not separated from Polypodioids. The citation of synonyms is often uncritical. The work is of value mainly for its ecological information, but where species have been confused (e.g. under *Dryopteris uliginosa*) ecological information is also confused.

*The present situation.* At the beginning of this volume (p. ii, 1959) I presented a tentative list of genera, remarking that much new information would arise in the course of study in the production of the present Flora, and that new ideas on classification would probably emerge. I refrained from assigning the majority of genera of leptosporangiate ferns to families. In part 2 (1963) I showed *Dicksonia* and *Cyathea* to be much more nearly allied than I had thought in 1959. The inter-relations between genera there presented still appear sound, but the assignment of genera to families is still uncertain. In part 3 (1971) K. U. KRAMER presented a major revision of the genera of the *Lindsaea* group, clarifying distinctions between them and making a new subdivision of *Lindsaea*. Part 4, on the *Lomariopsis* group (as delimited by me in 1947) included much new information, especially on *Elaphoglossum* and *Bolbitis*, with a revised account of my earlier work on the other genera. The present part attempts a new subdivision and conspectus of the *Thelypteris* group of genera, which is so sharply distinct from other groups that I judge it to deserve family status. This decision commits us in some measure to the ultimate recognition of other families, but for this we still need more evidence. I think that the elaborate arrangement of PICHI SERMOLLI (1977) is premature, though it is much nearer to being natural than COPELAND's of 1947.

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We need more information about significant characters, and to be useful they must be available for all species; but no-one can tell in advance which characters will be significant. Since MANTON's book of 1950 the observation of chromosome numbers in a great range of ferns has provided important new evidence; but chromosome number by itself, without evidence of conformity with some quite different characters, can be misleading, and the proportion with species with known chromosome numbers is still relatively small in some genera and not easily augmented. As a result of the work by MANTON and others it has become clear that phenomena like hybridization and polyploidization — formerly regarded to be extremely rare in ferns — commonly occur also in tropical ferns. The impact of cytotaxonomic work on fern classification has recently been thoughtfully dealt with by LOVIS (1977) and WALKER (1979). KLEKOWSKI (1979) has contributed much to our knowledge of the reproductive biology of the ferns also in relation to polyploidy.

Morphologists can provide useful suggestions for characters of possible significance. Morphology and taxonomy are interdependent; morphology without a good taxonomy may arrive at wrong conclusions; taxonomy without the stimulus of morphology may miss important distinguishing characters. Features which have recently been shown to be of great significance for fern classification are stomata (VAN COTTHEM, 1970) and spores (LUGARDON, 1971). Gametophytes, formerly a neglected item, are important and often indicate relationships within the larger groups of ferns.

In the end, a practical taxonomy must rest on a limited number of characters which are observable without very elaborate equipment, which is one reason why uninformed academic botanists regard it as unscientific. I hope and believe that this Flora is producing new contributions to that end.

Work now in progress for further instalments of Flora Malesiana Series II is as follows. Dr E. HENNIPMAN, with collaborators, has begun a study of *Polypodiaceae* (*s.str.*); Prof. K. IWATSUKI is making progress with *Hymenophyllaceae*; Mr G. J. DE JONCHEERE is working on the *Davallia* group; Dr B. S. CROXALL is studying the complexities of *Grammitidaceae*; Prof. K. U. KRAMER has started on *Pteris*, which seems to me to be an isolated genus; Prof. T. C. CHAMBERS has made a world monograph of the genus *Blechnum* and it is hoped that he will be able to deal with the *Blechnum* group for Flora Malesiana; Mr A. C. JERMY is working on the complex genus *Selaginella*.

Of the other genera, *Dennstaedtia* is of basic importance. It is more diversified in the Philippines, New Guinea and the Pacific than in any other part of the world and, as the fronds are very large, existing herbarium material often does not give full information about them; more field work, by people who know what to look for, is needed. The most complex groups still not dealt with are those of *Tectaria* and *Athyrium*, the latter being very difficult, with need of much new observation, especially of scales. I have made studies of two genera of the *Tectaria* group and propose to continue with that group if I am able to do so. The *Adiantum* group (as listed in 1959) is complex, but not so well developed in Malesia as in drier climates, and is more dependent on studies of plants in such climates than are most other groups. This is true also of the *Dryopteris* group, which is mainly temperate in distribution.

December 1979

R. E. HOLTUM

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# 1. INTRODUCTORY NOTE

The work of preparation of a new survey of all the Pteridophytes of Malaysia will occupy a considerable period. It is proposed to publish this work in parts, as studies of particular families or genera are completed, but it is impossible to plan in advance the precise sequence of these studies.

It is anticipated that the new information to be recorded, and new ideas based upon it, will throw a good deal of new light on the delimitation of genera, and upon the inter-relationships of genera, especially among the ferns, which are by far the largest of the major groups concerned. Therefore one cannot now predict what final scheme of classification will emerge. But it is necessary to have some sort of conspectus at the start, as a preliminary survey of the ground to be covered, and as a guide for those who wish to consult the parts of the work as they appear. I have therefore drawn up a list of the major groups, with the genera in each, and also a series of keys to the genera of ferns. The nomenclature of the major groups, the generic concepts, and the keys, must all be regarded as tentative.

As regards the major groups, there are differences of opinion as to the status of each and as to the most appropriate names. I hope at least that the significance of the names here used is clear. As regards the ferns, there is still no general agreement as to the subdivision of the vast and heterogeneous assemblage formerly known as *Polypodiaceae*, though the more primitive families are clearly defined. In the conspectus which follows, I have arranged the genera of *Polypodiaceae sens. lat.* in Groups which seem to me to be natural, but I have given no formal names to the Groups, nor specified their status, except for *Polypodiaceae sens. strict.* and *Grammitidaceae*, which (with the exception of a few genera) are also accepted by COPELAND. The fern specimens in the Herbarium at Bogor are now arranged according to these Groups. Probably the Groups will be modified in any final re-assessment at the conclusion of their treatment in 'Flora Malesiana'. So far as possible, genera within a family or Group will be treated together.

There are two alternative General Keys, which lead to families or Groups of genera. In the first key a principal distinction is between epiphytes and terrestrial ferns; in the second key this distinction is not used.

The delimitation of some genera of ferns is still not clear, and the generic names are to be taken as tentative. In general, they are those accepted in COPELAND's *Genera Filicum* (1947), but there are some changes.

Critical literature on fern taxonomy up to the year 1934 is very fully listed in CHRISTENSEN's *Index Filicum* and its three *Supplements*. Some important books and papers subsequently published and dealing with Malaysian ferns are listed after the keys to genera.

R. E. HOLTUM

## 2. LIST OF MALAYSIAN PTERIDOPHYTES

### PSILOTOPSIDA

#### PSILOTALES

- Psilotaceae*
- Psilotum
- Tmesipteridaceae*
- Tmesipteris

### LYCOPSIDA

#### LYCOPODIALES

- Lycopodiaceae*
- Lycopodium
- Selaginellaceae*
- Selaginella
- Isoetaceae*
- Isoetes

### SPHENOPSIDA

#### EQUISETALES

- Equisetaceae*
- Equisetum

### PTEROPSIDA

#### OPHIOGLOSSALES

- Ophioglossaceae*
- Botrychium
- Helminthostachys
- Ophioglossum

#### MARATTIALES

- Marattiaceae*
- Angiopteris
- Christensenia
- Macroglossum
- Marattia

#### FILICALES

- Osmundaceae*
- Leptopteris
- Osmunda
- Schizaeaceae*
- Lygodium
- Schizaea
- Gleicheniaceae*
- Dicranopteris
- Gleichenia
- Hymenophyllaceae*
- Hymenophyllum
- Trichomanes
- Matoniaceae*
- Matonia
- Phanerosorus
- Cyatheaceae*
- Cyathea
- Polypodiaceae (s.str.)*
- Aglaoomorpha
- Arthromeris
- Belvisia
- Cheiropleuria
- Christiopteris

- Colysis
- Crypsinus
- Dendroconche
- Dendroglossa
- Diblemma
- Dipteris
- Drymoglossum
- Drynaria
- Goniophlebium
- Grammatopteridium
- Holcosorus
- Holostachyum
- Lecanopteris
- Lemmaphyllum
- Lepisorus
- Leptochilus
- Loxogramme
- Merinthosorus
- Microsorium
- Myrmecophila
- Neocheiropteris
- Oleandropsis
- Paragramma
- Photinopteris
- Platycerium
- Polypodiopsis
- Pynoloma
- Pyrrosia
- Selliguea
- Thayeria
- Thylacopteris

#### Grammitidaceae

- Acrosorus
- Calymmodon
- Ctenopteris
- Grammitis
- Nematopteris
- Oreogrammitis
- Prosaptia
- Scleroglossum
- Xiphopteris

#### REMAINING GENERA OF FERNS

(in Groups, alphabetically)

#### Adiantum Group

- Adiantum
- Anogramma
- Ceratopteris
- Cerosora
- Cheilanthes
- Coniogramme
- Doryopteris
- Hemionitis
- Notholaena
- Onychium
- Pellaea
- Pityrogramma
- Syngamma
- Schizolepton
- Taenitis

#### Asplenium Group

- Asplenium
- Diplora

#### Loxoscaphe

#### Athyrium Group

- Anisocampium
- Athyrium
- Callipteris
- Cornopteris
- Cystopteris
- Diplaziopsis
- Diplazium
- Dryoathyrium

#### Blechnum Group

- Blechnum
- Brainea
- Doodia
- Woodwardia

#### Davallia Group

- Araiostegia
- Davallia
- Davallodes
- Humata
- Leucostegia
- Parasorus
- Scyphularia
- Trogostolon

#### Dennstaedtia Group

- Dennstaedtia
- Histiopteris
- Hypolepis
- Microlepia
- Monachosorum
- Orthiopteris
- Paesia
- Pteridium

#### Dicksonia Group

- Cibotium
- Culcita
- Cystodium
- Dicksonia

#### Dryopteris Group

- Acrophorus
- Currania
- Diacalpe
- Didymochlaena
- Dryopteris
- Gymnocarpium
- Peranema
- Polystichum
- Polystichopsis
- Stenolepia

#### Lindsaea Group

- Isoloma
- Lindsaea
- Sphenomeris
- Tapeinidium

#### Lomariopsis Group

- Arthrobotrya
- Bolbitis
- Egenolfia
- Elaphoglossum
- Lomagramma
- Lomariopsis

## Morphology of ferns

Teratophyllum	Ctenitis	Dictyocline
Thysanosoria	Cyclopeltis	Sphaerostephanos
<i>Nephrolepis Group</i>	Dryopolystichum	Stegnogramma
Arthropteris	Hemigramma	Thelypteris
Nephrolepis	Heterogonium	<i>Vittaria Group</i>
Oleandra	Hypodematium	Antrophyum
<i>Plagiogyria Group</i>	Lastreopsis	Monogramma
Plagiogyria	Luerssenia	Vaginularia
<i>Pteris Group</i>	Pleocnemia	Vittaria
Acrostichum	Psomiocarpa	
Hemipteris	Pteridrys	HETEROSPOROUS FERNS
Lepidocaulon	Quercifilix	<i>Marsileaceae</i>
Pteris	Stenosemia	Marsilea
Schizostege	Tectaria	<i>Salvinaceae</i>
Stenochlaena		Azolla
<i>Tectaria Group</i>	<i>Thelypteris Group</i>	Salvinia
Arcypteris	Ampelopteris	
	Cyclosorus	

## 3. THE MORPHOLOGY OF FERNS

A fern plant consists of a stem, bearing leaves and roots. The leaves (or some of them) bear dehiscent *sporangia*, each sporangium containing unicellular spores, which are in most cases wind-dispersed. A spore germinates to produce a small green plant called a *prothallus*. The prothallus bears sexual organs (*archegonia* and *antheridia*). After fertilization by an antherozoid, the female cell in an archegonium grows to form a new fern plant. The life cycle of a fern thus has two phases, asexual (the fern plant) and sexual (the prothallus). These phases are also called the *sporophyte* and the *gametophyte*. The sporophyte is much longer-lived, larger and more diversified than the gametophyte, and its characters are mainly used in taxonomy. The following statement deals with the parts of the sporophyte in turn, with discussion of the kinds of modification of each which occur, and of special terminology. Finally, a note on the gametophyte will be given, including reference to the not infrequent condition in which the sexual process is omitted.

**Stem.** (a) *Shape, size, and habit of growth.*—A fern stem may be long and creeping or climbing, in which case it is usually called a *rhizome*, or it may be short and compact, in which case it is often called a *stock*, *rootstock* or *caudex*. If it grows erect, as in tree-ferns, with a tuft of leaves at its apex, it is called a *trunk*.

A creeping stem or rhizome may be *dorsiventral* or *radial* in construction. In the former case the leaves (or their stalks) are borne on the upper surface (often in two alternate rows, sometimes more than two), the roots entirely or mainly on the lower surface; the internal vascular structure corresponds to this external differentiation. In a radially constructed rhizome leaves and roots are borne on all sides (though of course the leaf-stalks all grow upwards), and the vascular system shows a corresponding radial symmetry.

A short stem or rootstock, bearing crowded leaves, is usually radial in construction. Such a stem may be quite erect, but more often it is more or less decumbent; the presence of a persistently erect rootstock is sometimes an important diagnostic character. Tree-ferns, and others in which the erect rootstock grows to an appreciable height above the surface of the ground, have numerous roots which may form a close covering on the lower part of the stem, thus giving stability to the plant.

(b) *Branching.*—In a few cases this is by simple *dichotomy* (the apical growing-point dividing into two equal parts). More frequently branches arise in association with the bases of leaf-stalks, usually on the outside. The method of branching may be important taxonomically; it has been too little studied.

(c) *Hairs, Bristles and Scales.*—The young parts of a stem are in almost all cases protected either by scales or hairs; similar scales or hairs also cover the very young leaves before they uncurl. Such scales and hairs are more or less persistent on older parts of stem and leaves.

*Hairs* consist of a single cell or of a single row of cells, and in different ferns are of characteristic length and thickness; the thicker ones are sometimes quite rigid and bristle-like. True *bristles*, which are more than one cell thick at the base, but round in section, also occur in some cases. *Scales* are flat plates of cells, one cell thick; the details of their structure (especially characters of edges, base and apex, and the presence or absence of superficial outgrowths) are often very important taxonomically and may need microscopic examination. A *peltate* scale is one attached at some point on its surface, not on its edge. Where lateral cell-walls of a scale are thickened so as to form a distinct lattice-work pattern, the scale is called *clathrate*; the upper and lower walls may or may not be translucent.

(d) *Internal Structure*.—The most important internal structure is the vascular tissue. The vascular strands which pass into leaves and roots are connected to the vascular system of the stem; the latter is called a *stele*, or if at any cross section it consists of more than one part, the parts are called *meristeles*. The simplest kind of stele is a *protostele*; in this there is one single solid strand of xylem with phloem around it, the whole surrounded by an endodermis. In some cases the xylem of a protostele is not solid, but has a core of non-vascular tissue; such a structure is called a *medullated protostele*. In some long-creeping rhizomes (e.g. *Microlepia*) the stele is a hollow cylinder, with phloem and endodermis both inside and outside the xylem; this is called a *solenostele* or *siphonostele*. In this case there is usually a gap in the stele where the vascular supply to a leaf is attached; such a gap is called a *leaf-gap*. Rhizomes of this type are usually dorsiventral. In *Davallia*, the solenostele does not consist of a continuous hollow cylinder, but the cylinder (not circular in section) is composed of a network, most of the gaps in which are not leaf-gaps. This may be called a *dissected solenostele*; in the case of *Davallia* it is dorsiventral, the ventral meristele being broader than the rest and bearing roots. In stems of radial structure bearing many leaves close together, the stele usually forms a hollow cylinder in which there are many leaf-gaps, these gaps being like the meshes in a network. Such a stele is called a *dictyostele*. In a few ferns there are additional steles internal to the principal stele (e.g. *Matonia*, some species of *Pteris*); also in a few there is a cortical system of stem-bundles outside the principal stele (e.g. *Stenochlaena*). Besides vascular tissue, most fern-stems contain thick-walled tissues which serve to give mechanical strength; the presence (or absence) and distribution of such tissue may be important.

**Roots.** Roots are all adventitious. The primary root of a fern-embryo, having no power of increasing in thickness, is soon inadequate to supply the needs of the growing plant, and further roots must grow from the stem (in some cases also from leaf-bases). Little use has been made of root characters for taxonomic purposes, but there is considerable diversity of root-structure among ferns as a whole. In some species of *Hymenophyllaceae* there appear to be no roots, the rhizome being covered with hairs which function as root-hairs.

**Leaves.** VEGETATIVE CHARACTERS. Fern-leaves are usually called *fronds*; their stalks or petioles are called *stipes*; the blade or flat green part of a leaf is called the *lamina*. The lamina is usually divided into parts called *leaflets*; the axes on which leaflets are borne are called *rachises* (*rhachis* is the more correct spelling, but *rachis* is in general use in English). Fronds may be *sterile* (lacking sporangia), or *fertile* (bearing sporangia); sterile and fertile fronds may be alike in form, or dissimilar (*dimorphous*).

(a) *Stipes*.—A stipe may be *jointed* or *articulated* at its junction with the stem, or in some cases it is articulated to an outgrowth from the stem called a *phyllopodium* (e.g. *Elaphoglossum*, *Oleandra*); but more commonly it is not articulated. Externally a stipe usually bears hairs or scales like those of the rhizome or caudex, but often smaller; sometimes the scales are borne at the ends of warts or thorns. In some cases where the rhizome bears only scales, the stipe (and rachis) may also bear hairs. The character of the hairs, whether unicellular or multicellular (with transverse *septa*), and whether terminating in a glandular cell, is always important. In a few ferns the stipe has slime-glands, producing mucilage when the fronds are very young, and elongate *aerophores*, the latter often in association with much-reduced leaflets. In any case, there is usually a pale and more or less raised line along each side of the stipe. This line is also

an aerophore; there are stomata on it, and internally the tissue is thin-walled, with air-spaces between the cells. The line is sometimes not continuous but broken, and sometimes doubled (*Cyathea*). Internally the number and arrangement of the vascular bundles in a stipe is important; often the number and arrangement change between the base and apex.

(b) *Branching of fronds*.—Fronds may be *simple* (consisting of a continuous lamina, which may be *entire* or *lobed* in various ways), or they may consist of two to many leaflets which are borne by the rachis or its branches. The commonest arrangement is for the main rachis (continuing the line of the stipe) to be almost straight, bearing leaflets (stalked or not, articulate or not) along its sides; such a frond is said to be *pinnate*, and the leaflets are called *pinnae*. Like a simple frond, a pinna may be *entire* or *lobed*; if *pinnately lobed*, the leaflet is *pinnatifid*, if *palmately lobed*, *palmatifid*. Where the rachis bears branches, these are usually arranged in a *pinnate* manner; if each such primary branch bears leaflets, the frond is said to be *bipinnate*, and the leaflets are called *pinnules*. If each primary branch bears secondary branches *pinnately* arranged, and the secondary branches bear leaflets, the frond is said to be *tripinnate*, and the leaflets are of the *third order*; fronds may also be *quadripinnate*. Pinnae or rachis-branches are usually *alternate* on the two sides of a main rachis, but in some cases they are regularly almost exactly *opposite* (e.g. *Gleichenia*). The edge of a leaflet on the side towards the apex of the frond is called *acroscopic*, that towards the base of the frond is called *basiscopic*. The terms *upper* and *lower* are used for the two surfaces of the leaflets; the upper surface is that facing the stem-apex (also called the *adaxial* surface, the lower surface being *abaxial*).

There are some cases in which the stipe is not continued into a single straight rachis, but forks into two equal branches at its apex; such a *dichotomous* branching is seen in fronds of young plants of *Lygodium*. The dichotomy may be repeated, in which case a fan-shaped frond results (*Schizaea dichotoma*, *Dipteris lobbiana*); or only the outer branch at each dichotomy may fork again, in which case *pedate* branching results. The ultimate branching of large fronds or of their veins is also often dichotomous, and one can trace a transition from dichotomous to *pinnate* branching in descending a frond to its base; the *pinnate* condition can thus be regarded as a development from the *dichotomous* one. *Pseudo-dichotomy* occurs in a few cases (notably in *Gleicheniaceae* and in *Lygodium*); in these a rachis bears a pair of opposite branches and then stops growing, its dormant apex remaining between the branches.

(c) *Shape of rachises and of junctions between them and with leaflets*.—In addition to the characters of superficial hairs and scales, and of internal vascular systems, rachises of ferns provide characters of another kind which are useful taxonomically. These characters relate to the way in which the structure of a smaller rachis is adjusted to that of a larger one where the two join, and ultimately to the relationship of a lateral leaflet to the rachis which bears it. Some rachises are rather deeply grooved on the upper surface, and where a smaller rachis joins a larger one, the groove of the latter is opened to admit that of the former. In some such cases (e.g. *Dryopteris*, *Athyrium*, *Pteris*) the midrib of a leaflet is also grooved, and a rachis-groove is open to admit the midrib-groove of a lateral leaflet; the edge of the leaflet is then more or less decurrent down the side of the rachis. In other cases the thickened *basiscopic* edge of a leaflet is decurrent on the edge of the rachis-groove (e.g. *Lindsaea*). Other rachises are not or only slightly grooved on the upper surface and there is no opening of the groove of a main rachis to admit that of a smaller one (e.g. *Thelypteris*, *Ctenitis*). In such cases the base of the lamina of a leaflet is decurrent on the side of the rachis, sometimes forming a small continuous ridge or wing. Characters such as this are constant throughout a genus, or even throughout a group of genera, and are often valuable diagnostically, especially in sterile fronds. I believe also that they may provide valuable evidence for those who are seeking a natural classification of ferns.

(d) *Venation*.—Veins mark the course of the vascular bundles in a leaf; they are usually evident on the surface, as the surface tissue over a vein is different from that over the rest of the lamina. The pattern of venation is always important taxonomically. In fronds which are thick and fleshy or leathery the veins are sometimes quite invisible on the surface, or only the

larger ones may be prominent; the pattern of venation can then be seen by clearing the frond (boiling it and then treating it with a bleaching agent; or boiling alone may be sufficient, due to replacement of internal air by water).

In large much-branched fronds the ultimate leaflets are usually small, with few veins in each, and these veins commonly end in lobes or teeth at the edge of the lamina. Such veins are *free*; a vein may fork once or more times, but the branches do not unite again at any point. Where leaflets are very small, the veins are often dichotomously branched, while larger leaflets usually have a *midrib* or *costa* with lateral veins which are simple or forked.

In larger leaflets the vein-pattern may be more complex, still with free veins. The sides of a leaflet may be deeply lobed (pinnatifid) with pinnate vein-groups in each lobe; the main vein of a lobe is then called a *costule* (e.g. *Thelypteris*, *Cyathea*). In a large number of ferns with large leaflets, the veins join neighbouring veins after branching, thus forming areas of lamina surrounded by veins; such areas are called *areoles*, and veins which unite with others are said to *anastomose*. The anastomosis may consist only in the formation of a single series of areoles along costae or costules (the rest of the veins ending freely) or it may form a more or less elaborate network occupying almost the whole lamina. In the latter case there are several possible patterns (e.g. *Cyclosorus*, *Tectaria*, *Goniophlebium*, *Acrostichum*). One useful character is the presence or absence of small veins which end freely inside the areoles.

At the ends of some veins are water-excreting pores or *hydathodes*, often evident on the upper surface of the lamina as distinctive spots (round or elongate) which in some cases may ultimately become covered with white scales due to deposits of salts left after the water originally holding them has evaporated. Such hydathodes may provide useful diagnostic characters (e.g. *Pyrrosia*, *Grammitis*, *Coniogramme*).

(e) *Surface characters of lamina*.—The lower surface of the lamina may be *glaucous* (covered with a pale blue-green waxy layer); this character often disappears if specimens are subject to much heat in drying. The lower surface in other cases may be more or less completely covered with a layer of white or yellow loose waxy powder; this is excreted from glandular hairs (e.g. *Pityrogramma*). Hairs on the lamina are always important, and often need to be examined with a microscope for the structure to be clearly evident. The nature and arrangement of stomata may in some cases be significant (e.g. *Schizaea*). The patterns of thickenings on walls of epidermal cells may be characteristic (or of the single cell-layer of filmy ferns); and in some ferns there are narrow *spicular cells* containing silica (e.g. *Vittaria*). In some ferns there are *false veins*, which are lines along which surface cells are more or less elongate and sometimes devoid of stomata, simulating the surface appearance of veins but with no underlying vascular tissue (e.g. *Angiopteris*, *Trichomanes* sect. *Crepidomanes*).

(f) *Polymorphism of fronds*.—In many ferns, the fronds of young plants have a distinctive shape different from that of fronds of mature plants; such young plants may offer useful diagnostic characters. Some high-climbing ferns of the *Lomariopsis* Group have leaves of distinctive shape on those parts of the plant which are near the ground (always in moist shady evergreen forest) on rocks or tree-trunks; such leaves are called *bathyphylls*, and the leaves of high-climbing parts of the same plants are called *acrophylls*.

FERTILE LEAVES. (a) *Sori*.—In most ferns sporangia are borne in distinct groups called *sori*. In some cases the sori spread along the veins to such an extent that they can hardly be called groups of sporangia, and this leads to the acrostichoid state (see below). Many sori are protected by *indusia*, which are thin outgrowths from the surface of a frond. The sori of other ferns are *exindusiate*, but in some of these the sori are protected by being produced in depressions or grooves, or by being covered when young by *paraphyses* (hairs of various forms, or scales, borne among the sporangia). The position and shape of sori and of their indusia (if present) are always important taxonomically. The older schemes of classification, and also that of HOOKER and BAKER (*Synopsis Filicum*, 1868) were based entirely on these characters. But species closely related in every other respect may differ in presence or absence of an indusium, or in shape of sori (especially if these lack indusia) and a natural classification must take such facts



into consideration. The Orders *Ophioglossales* and *Marattiales* are quite different from *Filicales* in the form and arrangement of their sporangia (see statement on sporangia below); further remarks here refer to *Filicales*.

A sorus may be more or less circular, or elongate. If circular, it may be at the end of a free vein (at the edge of the lamina or not) or seated upon a free vein, or at the junction of veins in a network, or at the end of a free vein enclosed in an areole surrounded by other veins. In any of these cases it may be protected by an indusium, which may be pocket-shaped (attached at base and sides), or kidney-shaped, or circular and attached by the edge or the centre, or cup-shaped, or of other shapes, or it may have no indusium. If the sorus is at the end of a vein, it may be protected by the thin reflexed edge of the lamina, or by two more or less equal outgrowths from upper and lower surface (*Dicksonia*), the two outgrowths sometimes more or less joined to form a protective funnel or cup (*Trichomanes*, *Dennstaedtia*). Sori which are elongate may spread along free veins, or along veins which anastomose, or they may spread along the margin, joining the ends of veins which in a sterile leaflet would be free (*fusion-sori* or *coenosori*) or they may lie close to the costa of a leaflet (*Blechnum*). Marginal fusion-sori are sometimes protected by an inner indusium (*Lindsaea*), sometimes also by the reflexed margin (*Pteridium*), but if the margin is reflexed, the inner indusium may be lacking (*Pteris*). It is especially exindusiate sori which spread along veins away from the margin, often to a different extent in closely related species. The above survey of soral form is not exhaustive, but is intended as an indication of the possibilities and as a guide in using the keys which follow. Details of individual soral forms will be given in the taxonomic treatment of the families and genera.

(b) *Dimorphism of leaves*.—In many ferns the fertile fronds differ in shape from sterile ones. In such cases the fertile fronds often have a lamina of reduced size; this reduction may be slight or it may be so considerable that the sterile and fertile fronds are quite different in aspect. Fertile fronds also often have longer stipes than sterile, and in some cases this may be the chief difference between the two.

(c) *The Acrostichoid state*.—Where sori spread along all the veins of a fertile leaflet and the leaflet is of reduced size as compared with a sterile one of the same species, the ripe sporangia may be so close together that they entirely cover the lower surface of the fertile leaflet (they may also grow from the surface of the lamina between the veins); this is called the *acrostichoid* condition, the name being taken from the *Acrostichum*, in which only the upper leaflets are fertile in this way. Formerly all acrostichoid ferns were included in the genus *Acrostichum*, but the acrostichoid state has certainly arisen along several different evolutionary lines, and a genus based on it alone is a very unnatural one. In some acrostichoid ferns there is an additional vascular system close to the lower surface of the lamina, in addition to the normal system found in sterile fronds of the same species.

**Sporangia.** (a) *Ophioglossales*.—Here the sporangia are large, spherical, opening by slits, and are attached to spike-like or branched outgrowths from the base of the lamina; the fertile part of the frond is thus not fern-like in aspect.

(b) *Marattiales*.—In this Order the sporangia are also large, more or less laterally joined together in linear or circular groups on the surface of the lamina (along veins or at vein-junctions); they do not have an annulus comparable with that of members of the Order *Filicales*.

(c) *Filicales*.—In the great majority of this order the sporangia have a basically similar structural plan, in which dehiscence is caused by contraction on drying of a more or less complete ring of cells (the *annulus*) which have inner walls thickened but outer walls thin; there is also a particular place (*stomium*) where rupture occurs. The more primitive families (*Osmundaceae*, *Schizaeaceae*, *Gleicheniaceae*) have a less specialized development of the annulus, that of *Osmundaceae* being the least specialized (its annulus is not ring-shaped). In *Hymenophyllaceae*, *Cyatheaceae*, *Plagiogyria* and some other genera the annulus is complete and *oblique* in its position on the sporangium; in the great majority of genera the annulus is almost *vertical* and incomplete, being broken by the stalk, but even in these cases the structure of the sporangium is not per-

fectly symmetrical when divided along the plane of the annulus. In some members of the *Adiantum* Group the cells of the annulus are broad and more or less uneven. A detailed study of the development and structure of sporangia has been made in comparatively few fern-genera.

**Spores.** Fern spores are always produced in groups of four (*tetrads*), each tetrad normally the result of the meiotic divisions of one spore-mother-cell. A spore may have either of two distinct shapes, *monolete* (or *bilateral*), and *trilete* (or *tetrahedral*). Monolete spores are more or less bean-shaped (like a *Phaseolus* seed), with an angle along the straight edge where the spore is in contact with the similarly angled edge of another spore of the tetrad; in each tetrad there are two such pairs. Trilete spores meet together on three faces, and at the angles between them, all four spores meeting at the centre of a tetrad. Usually all species in a genus have spores of the same shape, but there are certainly some genera in which both shapes of spores occur (*e.g.* *Dicranopteris*), and I have seen evidence that even within a single species there may be spores of both kinds.

The inner layer of cells in the wall of a sporangium (called the *tapetum*) breaks down during the development of the tetrads of spores, its substance being absorbed by the spores during their development. In some cases part of the substance of the tapetum forms an external covering on each spore, known as a *perispore*. The perispore is usually more or less folded into rather irregular wing-like structures, or sometimes into more regular spines. Other genera of ferns lack a perispore, and then the wall of the spore itself may be variously sculptured into a more or less complex pattern of warts or ridges. The presence or absence of a perispore, its structure if present, or the wall-characters where there is no perispore, are always of taxonomic importance as well as the actual size of the spores.

In the case of hybrids, where normal meiosis does not occur, there are often shrivelled empty spores, and the presence of such is always significant. In the case of apogamous ferns (see note on the gametophyte below) the spores are of at least two kinds, large functional ones and smaller ones which are not functional (for a detailed statement, see MANTON, *Problems of Cytology and Evolution in the Pteridophyta*, Cambridge, 1950).

**Gametophyte.** In *Ophioglossales* the gametophytes are subterranean and saprophytic, and obtain their nutriment through the activity of an endophytic fungus. In all other ferns the gametophytes are green, and in the vast majority of cases they are more or less heart-shaped, with a growing-point in the sinus between the two lobes; they are thickened in a median area which bears the rhizoids, antheridia and archegonia on the lower surface. Distinctive characters are provided by shape of the whole prothallus (in some cases this is asymmetric or elongate), presence of superficial hairs of different kinds, colour and septation of rhizoids, and especially in details of structure of archegonia and antheridia. In a few cases the gametophyte is more or less filamentous (*Schizaea*, *Hymenophyllaceae*), or irregularly lobed (*Vittaria* and allied genera).

In *apogamous* ferns, no sexual process occurs. The prothallus is developed from a diploid spore; it bears antheridia but no archegonia, and gives rise to a new sporophyte by vegetative budding. The diploid antherozoids of such a prothallus may fertilize haploid archegonia of a sexual prothallus of an allied species, the result being a triploid hybrid sporophyte. Such a hybrid is normally sterile, but may develop vegetative means of propagation not involving the formation of a prothallus; and some such hybrids have become apogamous. Higher polyploid plants are also not uncommon among ferns, and in such cases cytological evidence is of great taxonomic value.

**Heterosporous Ferns.** The two families *Salviniaceae* and *Marsileaceae* are very different from other ferns in many respects. They have spores of two kinds, large and small, in separate sporangia. The small spores produce very small gametophytes which are male, and the large spores produce larger female gametophytes. Both kinds of sporangia are formed inside closed structures called *sporocarps*, borne by the leaves. These ferns are all aquatic, and they are sometimes collectively called *Hydropterideae* or *Hydropteridales*, but the two families are not closely related, and probably had quite different evolutionary histories.

## 4. GENERAL KEY No 1 to PTEROPSIDA

1. Aquatic plants.
  2. Plants floating. Leaves small, simple or bilobed . . . . . **Salvinaceae**
  2. Plants rooted in earth or on rocks. Leaves larger, more divided.
    3. Leaves 4-partite. Sporocarps attached to stipes. . . . . **Marsileaceae**
    3. Leaves not 4-partite. Sporangia singly or in sori on lower surface of lamina.
      4. Sporangia borne singly, protected by reflexed edges of narrow lamina . . . **Adiantum Group**
      4. Sporangia grouped in sori, on lower surface of lamina, not protected by reflexed edges.
        5. Fern of stream-beds in deep shade. Fronds pinnatifid, sori without indusia **Polypodiaceae**
        5. Fern of open swamps. Fronds bipinnatifid, sori indusiate. . . . . **Thelypteris Group**
1. Land plants or epiphytes.
  6. Epiphytes.
    7. Fronds simple, not over 2 mm wide, with a single vein, or with a few simple lateral soriferous veins close to the main vein . . . . . **Vittaria Group**
    7. Fronds branched, or if simple with a more complex venation.
      8. Lamina one cell thick apart from midribs of segments . . . . . **Hymenophyllaceae**
      8. Lamina throughout more than one cell thick.
        9. Sporangia embedded in slender cylindrical appendages attached to surface of frond. **Ophioglossaceae**
        9. Sporangia not so arranged.
          10. Sori not indusiate (sometimes otherwise protected).
            11. Sporangia not acrostichoid.
              12. Sori superficial (not in pockets or grooves).
                13. Fronds simple, pinnatifid or pinnate; if pinnate, pinnae not articulate to rachis.
                  14. Veins much anastomosing . . . . . **Polypodiaceae**
                  14. Veins not or slightly anastomosing.
                    15. Frond and stipe  $\pm$  hairy; spores trilete . . . . . **Grammitidaceae**
                    15. Frond and stipe not hairy; spores monolete . . . . . **Polypodiaceae**
                13. Fronds pinnate, pinnae articulate to rachis.
                  16. Pinnae entire . . . . . **Polypodiaceae**
                  16. Pinnae lobed . . . . . **Nephrolepis Group**
              12. Sori in pockets or grooves (which are sometimes marginal).
                17. Sori in pockets or depressions,  $\pm$  circular.
                  18. Veins anastomosing; or, if free, fronds not hairy . . . . . **Polypodiaceae**
                  18. Veins free, fronds more or less hairy . . . . . **Grammitidaceae**
                17. Sori elongate, in grooves.
                  19. Grooves all evenly oblique to costa . . . . . **Polypodiaceae**
                  19. Grooves marginal or parallel to margin, or uneven in direction, sometimes anastomosing.
                    20. Scales entirely opaque, usually brown . . . . . **Grammitidaceae**
                    20. Scales nearly black, strongly clathrate, lumina of cells translucent **Vittaria Group**
            11. Sporangia acrostichoid, covering entirely part or whole of a frond.
              21. Veins much anastomosing; spores without perispore . . . . . **Polypodiaceae**
              21. Veins free or slightly anastomosing near edge; perispore present . **Lomariopsis Group**
        10. Sori indusiate.
          22. Sori elongate along veins . . . . . **Asplenium Group**
          22. Sori otherwise.
            23. Sori elongate along edge of lamina.
              24. Pinnae articulate to rachis . . . . . **Nephrolepis Group**
              24. Pinnae (if any) not articulate to rachis.
                25. Rhizome protostelic . . . . . **Lindsaea Group**
                25. Rhizome with more complex vascular system . . . . . **Davallia Group**
            23. Sori otherwise.
              26. Fronds articulate to rhizome.
                27. Sori at ends of veins, near edge of lamina.
                  28. Pinnae (if present) not jointed to rachis. . . . . **Davallia Group**
                  28. Pinnae jointed to rachis . . . . . **Nephrolepis Group**
                27. Sori close to costa of the simple frond . . . . . **Nephrolepis Group**
              26. Fronds not articulate to rhizome . . . . . **Nephrolepis Group**
      6. Terrestrial plants, or climbers starting from the ground, or rock-plants.
        29. High-climbing rhizome starting from the ground.
          30. Rhizome not dorsiventral; veins anastomosing in a narrow series of costal areoles (seen at apex of pinna) . . . . . **Pteris Group**
          30. Rhizome dorsiventral; veins either free or much anastomosing . . . **Lomariopsis Group**
        29. Terrestrial or rock plants.

31. Caudex massive, erect; stipes succulent, with stipule-like outgrowths at their bases; bases of pinnae swollen . . . . . **Marattiaceae**
31. Not these characters.
32. Lamina one or two cells thick apart from midribs of segments of lamina; no stomata.
33. Sporangia attached to elongating slender receptacles in funnel-shaped pockets at ends of veins. **Hymenophyllaceae**
33. Sporangia attached to surface of veins . . . . . **Osmundaceae**
32. Lamina throughout more than two cells thick; stomata present.
34. Caudex or rhizome at apex, and bases of stipes, hairy or bristly (no flat scales) or apparently naked.
35. Rootstock massive, erect (in a few cases tree-like) or more or less decumbent, radially organized, its apex above ground, bearing a close group of fronds.
36. Fronds simply pinnate; apex of caudex not densely hairy.
37. Aerophores at bases of stipes (sometimes also at bases of pinnae) **Plagiogyria Group**
37. Aerophores lacking . . . . . **Osmundaceae**
36. Fronds more amply divided; apex of caudex densely hairy . . . . . **Dicksonia Group**
35. Rootstock otherwise, usually entirely below ground.
38. Fertile part of frond not leaf-like, erect and attached to base of leafy part **Ophioglossaceae**
38. Fertile part of frond leaf-like, sometimes reduced in size as compared with sterile.
39. Fronds palmately divided; leaflets 3 or 5; veins anastomosing . . . . . **Marattiaceae**
39. Fronds otherwise.
40. Veins much anastomosing, with free veins in the areoles . . . . . **Polypodiaceae**
40. Veins in most cases free; where anastomosing, no free veins in areoles.
41. Sori quite superficial, on lower surface of lamina, or in a marginal groove.
42. Sori indusiate; fronds fan-shaped or slender and trailing . . . . . **Matoniaceae**
42. Sori not indusiate.
43. Fronds repeatedly pseudo-dichotomous, with a dormant apex between each pair of branches . . . . . **Gleicheniaceae**
43. Fronds otherwise . . . . . **Adiantum Group**
41. Sori at ends of veins or on special appendages.
44. Sporangia on special appendages which are at ends of veins of leaflets or attached near apex of frond or of its branches . . . . . **Schizaeaceae**
44. Sporangia in sori at ends of single veins or uniting ends of several veins, not on special appendages . . . . . **Dennstaedtia Group**
34. Caudex or rhizome at apex, and bases of stipes (at least when young) scaly.
45. Sporangia acrostichoid.
46. Rhizome dorsiventral, creeping on rocks.
47. Veins free, or if anastomosing the free veins almost all pointing outwards; spores with perispore . . . . . **Lomariopsis Group**
47. Veins much anastomosing with free veins in areoles pointing all ways; no perispore. **Polypodiaceae**
46. Rhizome not dorsiventral, often massive, bearing a tuft of fronds at its apex.
48. Only the upper pinnae fertile; veins much anastomosing, no free veins in areoles. **Pteris Group**
48. Whole frond fertile; in sterile frond veins free or anastomosing otherwise.
49. Veins free in sterile fronds, or a single row of costal areoles present.
50. Fertile frond simply pinnate . . . . . **Blechnum Group**
50. Fertile frond bipinnate . . . . . **Tectaria Group**
49. Veins much anastomosing in sterile fronds . . . . . **Tectaria Group**
45. Sporangia not acrostichoid.
51. Sorus along edge of lamina, continuous or nearly so.
52. Edge of lamina reflexed, protecting sori.
53. Rachis grooved on upper surface, groove open to admit groove of midrib of pinna. **Pteris Group**
53. Rachis not so grooved (if grooved, edge of lamina may be decurrent on edge of groove). **Adiantum Group**
52. Edge of lamina not reflexed; sorus protected by indusium attached below it, opening towards edge of lamina . . . . . **Lindsaea Group**
51. Sorus otherwise.
54. Sorus elongate, continuous along each side of costa of pinna . . . . . **Blechnum Group**
54. Sorus otherwise.
55. Sporangia on surface of reflexed marginal lobes . . . . . **Adiantum Group**
55. Sporangia not on such lobes.
56. Sorus along veins (at least some of them).
57. Sorus indusiate.

58. Sorus symmetrically divided by line of vein.  
 59. Rachis grooved, groove open to admit groove of branch; scales lacking superficial hairs . . . . . **Dryopteris Group**  
 59. Rachis somewhat grooved, groove not open to admit groove of pinna; scales with superficial hairs . . . . . **Thelypteris Group**
58. Sorus asymmetric, or on one side of vein.  
 60. Sori along outer veins of costular or costal areoles . . . . . **Blechnum Group**  
 60. Sori otherwise.  
 61. Two strands in stipe, uniting upwards to form a single X-shaped strand. . . . . **Asplenium Group**  
 61. Two strands in stipe, uniting upwards to form a single U-shaped strand. . . . . **Athyrium Group**
57. Sorus not indusiate.  
 62. Sori spreading along all veins of lower surface.  
 63. Slender unicellular hairs present on frond and on scales . . . . . **Thelypteris Group**  
 63. Slender unicellular hairs lacking . . . . . **Adiantum Group**  
 62. Sori not spreading along all veins.  
 64. Several vascular bundles in stipe . . . . . **Tectaria Group**  
 64. Two vascular bundles at base of stipe, uniting upwards.  
 65. Waxy powder on lower surface of lamina . . . . . **Adiantum Group**  
 65. No waxy powder present . . . . . **Athyrium Group**
56. Sori not along veins.  
 66. Sori at ends of veins, at or close to edge of lamina, each in the base of a cup, or protected by an indusium attached below it or by the reflexed edge of the lamina.  
 67. Sori each in the base of a cup . . . . . **Dennstaedtia Group**  
 67. Sori protected by indusia or by edge of lamina.  
 68. Sori protected by indusia opening outwards.  
 69. Pinnæ articulate to rachis . . . . . **Nephrolepis Group**  
 69. Pinnæ not articulate . . . . . **Lindsaea Group**  
 68. Sori protected by reflexed edge of lamina.  
 70. An inner indusium also present; rachis grooved, groove open to admit groove of midrib of pinna . . . . . **Pteris Group**  
 70. An inner indusium lacking; rachis not grooved, or if grooved, edge of pinna decurrent on edge of groove . . . . . **Adiantum Group**
66. Sori not at ends of veins, or if so not close to edge of lamina.  
 71. Rhizome dorsiventral.  
 72. Sori without indusium.  
 73. Fronds lacking dormant apices . . . . . **Polypodium Group**  
 73. Fronds always having some dormant apices . . . . . **Gleicheniaceae**  
 72. Sori indusiate.  
 74. Fronds simple . . . . . **Nephrolepis Group**  
 74. Fronds pinnately branched . . . . . **Davallia Group**
71. Rhizome not dorsiventral.  
 75. Fronds simple and jointed at base, or pinnate with pinnæ jointed to rachis. . . . . **Nephrolepis Group**  
 75. Fronds otherwise.  
 76. Tree-ferns; sporangia with complete oblique annulus; many vascular bundles in stipe . . . . . **Cyatheaceae**  
 76. Not tree-ferns; annulus vertical, interrupted; vascular bundles in a simple ring (except *Pleocnemia*).  
 77. Rachis grooved, groove open to admit groove of branch-rachis or pinna.  
 78. Several vascular bundles in stipe . . . . . **Dryopteris Group**  
 78. Two bundles, joining to form one of U-shape. . . . . **Athyrium Group**  
 77. Rachis not grooved, or if grooved groove not open to admit groove of branch.  
 79. Hairs (if present) multicellular; scales lacking superficial hairs or glands.  
 80. Several vascular bundles in stipe . . . . . **Tectaria Group**  
 80. Two bundles, joining to U-shape . . . . . **Athyrium Group**  
 79. Hairs unicellular; scales bearing superficial hairs or glands **Thelypteris Group**

## 5. GENERAL KEY No 2 to PTEROPSIDA

1. Aquatic plants.
  2. Plants floating; leaves small, simple or bilobed . . . . . **Salviniaceae**
  2. Plants rooted in earth or on rocks; leaves larger, more divided.
    3. Leaves 4-partite; sporocarps attached to stipes . . . . . **Marsileaceae**
    3. Leaves not 4-partite; sporangia singly or in sori on lower surface of lamina.
      4. Sporangia borne singly, protected by reflexed edges of narrow lamina . . . **Adiantum Group**
      4. Sporangia grouped in sori, on lower surface of lamina, not protected by reflexed edges.
        5. Fern of stream-beds in deep shade; fronds pinnatifid, sori without indusia **Polypodiaceae**
        5. Fern of open swamps; fronds bipinnatifid, sori indusiate . . . . . **Thelypteris Group**
1. Land plants or epiphytes.
  6. Stipe containing 3 or more vascular bundles throughout.
    7. Rhizome in most cases dorsiventral, stipes jointed to it or to phyllopodia borne by rhizome.
      8. Sori of various form (in some cases acrostichoid), not indusiate.
        9. Fronds pinnate; pinnae articulate to rachis, veins free . . . . . **Nephrolepis Group**
        9. Fronds rarely pinnate; pinnae (if present) not articulate to rachis, or if so veins reticulate.
          10. Acrostichoid; spores with perispore; veins free or uniting near margin **Lomariopsis Group**
          10. Acrostichoid or not; no perispore; where acrostichoid, veins much anastomosing.
            11. Sori indusiate.
              11. Fronds simple.
                12. Sori near midrib of frond . . . . . **Nephrolepis Group**
                12. Sori at ends of veins, solitary or joining many veins . . . . . **Davallia Group**
              11. Fronds more or less branched.
                13. Pinnae jointed to rachis . . . . . **Nephrolepis Group**
                13. Pinnae not jointed to rachis . . . . . **Davallia Group**
        7. Rhizome not dorsiventral, or if so the stipes not jointed to it.
          14. Stipes containing numerous bundles in a complex pattern, not a simple ring, in cross section.
            15. Rootstock massive, short or tall; if creeping, subterranean.
              16. Mangrove plants; distal pinnae acrostichoid, lower ones sterile . . . . **Pteris Group**
              16. Not mangrove plants; not acrostichoid.
                17. Stock and stipes containing woody tissue; no stipules at bases of stipes.
                  18. Veins free . . . . . **Cyatheaceae**
                  18. Veins anastomosing . . . . . **Tectaria Group**
                17. Stock and stipes without woody tissue; stipules present at bases of stipes.
                  19. Rootstock slender, long-creeping or high-climbing . . . . . **Marattiaceae**
                  19. Rootstock containing a simple open ring of bundles.
                    20. Sporangia on a separate branch attached at base of lamina, or to surface of lamina; no annulus.
                      21. Sporangia not on a separate branch of frond; annulus present.
                        22. Fronds pinnate or bipinnate, leaflets jointed to rachis.
                          23. Fronds in close tufts, not spaced on a climbing rhizome; sori separate and indusiate.
                            24. Fronds spaced on a climbing rhizome; sori not indusiate, in most cases acrostichoid.
                              25. Fronds (if present) not jointed to rachis.
                                26. Fronds simple, sori oblique, exindusiate . . . . . **Polypodiaceae**
                                26. Fronds otherwise.
                                  27. Sori elongate, either close to midrib or to edge.
                                    28. Sori close to midrib . . . . . **Blechnum Group**
                                    28. Sori close to edge . . . . . **Nephrolepis Group**
                                  27. Sori not elongate near midrib or edge.
                                    29. Sporangia acrostichoid, edge of lamina in some cases reflexed.
                                      30. Veins of sterile leaflets free.
  31. Fronds bipinnate . . . . . **Tectaria Group**
  31. Fronds simply pinnate.
  32. Rhizome creeping, dorsiventral . . . . . **Lomariopsis Group**
  32. Rhizome erect, radially arranged . . . . . **Blechnum Group**
  30. Veins of sterile leaflets anastomosing.
  33. Rhizome creeping, dorsiventral . . . . . **Lomariopsis Group**
  33. Rhizome erect, not dorsiventral . . . . . **Tectaria Group**
                          20. Sporangia not acrostichoid.
                            30. Rachis grooved, groove open to admit branches or midribs of leaflets.
                              31. . . . . **Dryopteris Group**

## General key No. 2 to Pteropsida

30. Rachis not grooved, its wings (if any) confluent with edges of lamina. **Tectaria Group**
6. Stipe containing one vascular bundle, or two at the base joining upwards to form a single strand of various shape.
31. Rhizome-apex and bases of stipes hairy or apparently glabrous, not scaly.
32. Fronds repeatedly pseudo-dichotomous, a dormant apex between pairs of branches. **Gleicheniaceae**
32. Fronds otherwise branched.
33. Apices of some or all primary rachis-branches dormant.
34. Rachis climbing and twining; sporangia solitary . . . . . **Schizaeaceae**
34. Rachis trailing, not twining; several sporangia in a sorus, indusiate . . . **Matoniaceae**
33. Apices of primary rachis-branches not dormant (apex of main rachis sometimes periodically dormant).
35. Sori at ends of veins, either in cups or protected by two equal or subequal flaps.
36. Filmy ferns; lamina one cell thick . . . . . **Hymenophyllaceae**
36. Not filmy, lamina thicker.
37. Massive rootstock, prostrate or erect and trunk-like, densely covered with long hairs. **Dicksonia Group**
37. Slender creeping rhizome; hairs short . . . . . **Dennstaedtia Group**
35. Sori otherwise.
38. Bases of stipes bearing prominent aerophores; fronds dimorphous, fertile with narrow acrostichoid pinnae . . . . . **Plagiogyria**
38. Bases of stipes lacking aerophores; fertile fronds otherwise.
39. Sporangia large, round, lacking an annulus, on deeply dissected pinnae **Osmundaceae**
39. Sporangia otherwise.
40. Sporangia variously arranged on lower surface of fronds, usually along the veins, or in a submarginal groove, not indusiate.
41. Sori elongate . . . . . **Adiantum Group**
41. Sori small and round, or acrostichoid . . . . . **Polypodiaceae**
40. Sporangia arranged otherwise.
42. Annulus almost apical; fronds simple or branched dichotomously; sporangia on special appendages . . . . . **Schizaeaceae**
42. Annulus and frond otherwise.
43. Fronds pedately branched; sori superficial, indusiate . . . . . **Matoniaceae**
43. Fronds pinnately branched; sori at ends of veins, indusiate or not. **Dennstaedtia Group**
31. Rhizome-apex and bases of stipes scaly.
44. Sporangia on surface of reflexed marginal lobes . . . . . **Adiantum Group**
44. Sporangia not on such lobes.
45. Sori elongate along the veins of the lower surface.
46. Sori indusiate.
47. Scales clathrate; the 2 vascular bundles at base of stipe uniting upwards to an X-shape. **Asplenium Group**
47. Scales not clathrate; the 2 vascular bundles at base of stipe uniting upwards to a U-shape.
48. Unicellular slender hairs lacking . . . . . **Athyrium Group**
48. Unicellular slender hairs on frond and on scales . . . . . **Thelypteris Group**
46. Sori not indusiate.
49. Fronds simple; sori in grooves (or rarely superficial); epiphytes or rock-plants. **Vittaria Group**
49. Fronds usually not simple; sori not in grooves; not epiphytes or rock-plants.
50. Sori not occupying whole length of veins.
51. Lower surface of lamina not covered with powder . . . . . **Athyrium Group**
51. Lower surface of lamina covered with powder . . . . . **Adiantum Group**
50. Sori occupying whole length of veins.
52. Slender unicellular hairs lacking on lamina and scales . . . . . **Adiantum Group**
52. Slender unicellular hairs present on lamina and scales . . . . . **Thelypteris Group**
45. Sori not elongate along the veins of the lower surface (in some cases elongate along a sub-marginal vein).
53. Sori in marginal or submarginal grooves, or superficial and forming continuous lines parallel to midrib.
54. Scales clathrate . . . . . **Vittaria Group**
54. Scales not clathrate . . . . . **Grammitidaceae**
53. Sori otherwise.
55. Sori at ends of veins (uniting several veins or not) protected by reflexed edge of lamina.
56. Rachis grooved on upper surface, groove opening to admit groove of midrib of pinna. **Pteris Group**

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56. Rachis not grooved in this way . . . . . **Adiantum Group**
55. Sori not at ends of veins or not so protected.
57. Lower surface of frond more or less covered with white or yellow powder.  
**Adiantum Group**
57. Lower surface of frond not so covered.
58. Sori submarginal, at ends of veins, in small projecting cups, or protected by an indusium attached on the side remote from the margin.
59. Sori in cups projecting from margin . . . . . **Dennstaedtia Group**
59. Sori not in such cups.
60. Sori always solitary at ends of single veins; scales of rhizome bearing papillae on marginal cells; rhizome not protostelic . . . . . **Davallia Group**
60. Sori often uniting ends of several veins; scales lacking papillae; rhizome protostelic.  
**Lindsaea Group**
58. Sori otherwise.
61. Main rachis of fronds periodic in growth; thicket-forming ferns . . . **Gleicheniaceae**
61. Main rachis of fronds continuous in growth; not thicket-forming ferns.
62. Small epiphytes (occasionally on rocks); sori superficial or immersed in pockets in substance of the lamina, not indusiate . . . . . **Grammitidaceae**
62. Not epiphytes; sori in most cases indusiate.
63. Hairs on fronds unicellular (in rare cases very long hairs may consist of more than one cell).
64. Scales confined to swollen basal part of stipe; no superficial hairs or glands on scales.  
**Tectaria Group**
64. Scales not so confined, bearing superficial unicellular hairs or glands.  
**Thelypteris Group**
63. Hairs on fronds multicellular, cells short . . . . . **Athyrium Group**



## 6. KEYS TO THE GENERA OF PTEROPSIDA

### OPHIOGLOSSACEAE

1. Sporangia in two rows, embedded in an almost terete spike . . . . . **Ophioglossum**
1. Sporangia on branches of the fertile segment of a frond.
  2. Fertile segment of frond compact, with many short branches; sterile segment tripartite, each part with few leaflets . . . . . **Helminthostachys**
  2. Fertile segment of frond amply branched with spreading branches; sterile segment (in Malaysian species) pinnately branched with many small divisions . . . . . **Botrychium**

### MARATTIACEAE

1. Sporangia in each group along the veins near margins of leaflets; veins free.
  2. Sporangia in each group united laterally . . . . . **Marattia**
  2. Sporangia in each group almost free.
    3. Fronds bipinnate; sporangia in each group commonly 8–12, less often to 20 . . . . . **Angiopteris**
    3. Fronds simply pinnate; sporangia in each group much more numerous . . . . . **Macroglossum**
1. Sporangia in each group united laterally to form a small circle, the circular groups scattered over the surface; veins anastomosing . . . . . **Christensenia**

### OSMUNDACEAE

1. Fertile pinnae quite different from sterile, lacking a green lamina; lamina of sterile pinnae not translucent . . . . . **Osmunda**
1. Fertile pinnae not different from sterile in shape; lamina very thin and translucent . . . . . **Leptopteris**

### SCHIZAEACEAE

1. Fronds of adult plant dichotomously branched or simple, the fertile lobes at the end of a frond or of its branches . . . . . **Schizaea**
1. Fronds of adult plants scandent (rachis twining) with very short primary rachis-branches bearing leafy secondary branches . . . . . **Lygodium**

### GLEICHENIACEAE

1. Rhizome and resting apices of fronds bearing multicellular hairs which are branched near the base; veins always at least twice forked . . . . . **Dicranopteris**
1. Rhizome and resting apices of fronds bearing flat scales, rest of fronds usually also stellate hairs (one cell to each ray); veins simple or forked once . . . . . **Gleichenia**

### HYMENOPHYLLACEAE\*

1. Lips of indusium always well developed, broader and longer than the hollow basal part; receptacle usually much shorter than the lips of the indusium (an elongate receptacle in *Meridium* PRESL). . . . . **Hymenophyllum**
1. Indusium tubular or trumpet-shaped, sometimes with two-lipped mouth; receptacle usually elongating considerably and protruding from old sori . . . . . **Trichemanes**

### MATONIACEAE

1. Fronds erect, branching pedate-dichotomous . . . . . **Matonia**
1. Fronds drooping, elongate, pinnately branched with apices of some branches dormant. . . . . **Phanerosorus**

### CYATHAEACEAE

Note. Probably all species will be united in the genus *Cyathea* (see HOLTUM, Kew Bulletin 1957, pp. 41–45).

### POLYPODIACEAE

1. Rhizome bristly or hairy, stipes not jointed to it; terrestrial.
  2. Fronds dimorphous; fertile fronds narrow, acrostichoid . . . . . **Cheiropleuria**
  2. Fronds uniform; sori small and round . . . . . **Dipteris**
1. Rhizome scaly, stipes usually jointed to it; mostly epiphytes.
  3. Young sori protected by umbrella-shaped paraphyses.
    4. Sporangia acrostichoid on a constricted apical part of the frond . . . . . **Belvisia**
    4. Sporangia in separate sori, or whole fertile frond narrow and acrostichoid.
      5. Sori somewhat elongate, close to and parallel with edge of lamina . . . . . **Paragramma**

\* For a much fuller subdivision of this family, see COPELAND, *Genera Filicum* (1947) pp. 31–44.

5. Sori otherwise.  
 6. Fronds small, fertile ones (or fertile parts) contracted . . . . . **Lemmaphyllum**  
 6. Fronds larger, not dimorphous . . . . . **Lepisorus** and **Neocheiropteris**
3. Young sori not so protected.  
 7. Fronds bearing stellate hairs.  
 8. Fronds simple, entire.  
 9. Sori continuous along margin of narrow fertile frond or between margin and midrib. **Drymoglossum**  
 9. Sori separate, round, variously distributed . . . . . **Pyrrosia**  
 8. Fronds branched dichotomously, sporangia acrostichoid on part of surface of fertile frond. **Platynerium**
7. Fronds not bearing stellate hairs.  
 10. Sori at the ends of free veins (veins conspicuous).  
 11. All veins free . . . . . **Thylacopteris**  
 11. Some veins anastomosing . . . . . **Goniophlebium**  
 10. Sori not at ends of free veins (veins often inconspicuous).  
 12. Veins anastomosing to form only one series of areoles along costae . . . **Polypodiopsis**  
 12. Veins more copiously anastomosing.  
 13. Rhizome swollen and ant-inhabited.  
 14. Rhizome not scaly; sori on distinct small lobes . . . . . **Lecanopteris**  
 14. Rhizome copiously scaly; sori not on distinct lobes . . . . . **Myrmecophila**  
 13. Rhizome not ant-inhabited.  
 15. Fertile fronds (or fertile parts) acrostichoid, usually much reduced as compared with sterile.  
 16. Fronds pinnate or pinnatifid, lower pinnae or lobes always sterile.  
 17. Fronds pinnate, sterile pinnae jointed to rachis . . . . . **Photinopteris**  
 17. Fronds pinnatifid . . . . . **Merinthosorus**  
 16. Fertile fronds wholly fertile.  
 18. Fronds strongly trilobed . . . . . **Christiopteris**  
 18. Fronds simple.  
 19. Fronds thin, all veins visible.  
 20. Fronds c. 10 cm long; terrestrial . . . . . **Dendroglossa**  
 20. Fronds c. 30 cm long; rock-plants or epiphytes . . . . . **Leptochilus**  
 19. Fronds coriaceous, at most main veins visible.  
 21. Sterile fronds narrow . . . . . **Oleandropsis**  
 21. Sterile fronds circular to broadly lanceolate.  
 22. Sterile fronds circular . . . . . **Pyncnoloma**  
 22. Sterile fronds longer than wide, apex acute . . . . . **Grammatopteridium**
15. Fertile fronds (or fertile parts) not acrostichoid.  
 23. Fronds pinnate or pinnatifid, pinnae or segments jointed to rachis.  
 24. Separate short humus-collecting fronds present . . . . . **Drynaria**  
 24. Separate humus-collecting fronds lacking.  
 25. Bases of fronds broad, humus-collecting.  
 26. Fronds on special branches of rhizome . . . . . **Thayeria**  
 26. Fronds not on special branches . . . . . **Aglaomorpha**  
 25. Bases of fronds not humus-collecting.  
 27. Fronds dimorphous . . . . . **Holostachyum**  
 27. Fronds not dimorphous . . . . . **Arthromeris**
23. Fronds simple or pinnatifid, segments not jointed to rachis.  
 28. Separate humus-collecting fronds present . . . . . **Dendroconche**  
 28. Separate humus-collecting fronds lacking.  
 29. Sori elongate, oblique, parallel to main lateral veins.  
 30. Fronds thin, all veins visible . . . . . **Colysis**  
 30. Fronds fleshy or leathery, at most main veins visible.  
 31. Main lateral veins distinct; scales not clathrate . . . . . **Selliguea**  
 31. Main lateral veins not distinct; scales clathrate . . . . . **Loxogramme**
29. Sori otherwise.  
 32. Sori elongate, near margins of thin frond . . . . . **Diblemma**  
 32. Sori otherwise.  
 33. Fronds very narrow, not dimorphous; sori elongate, close to costa . **Holcosorus**  
 33. Fronds otherwise; sori round.  
 34. Fronds always coriaceous; edges usually notched; scales not clathrate. **Crypsinus**  
 34. Fronds not always coriaceous; edges not notched; scales clathrate **Microsorium**

GRAMMITIDACEAE

- 1. Fronds simple and entire or with somewhat undulate edges.
- 2. Sori round or obliquely elliptical, separate . . . . . **Grammitis**
- 2. Sori elongate parallel to costa and edge, or confluent near apex of frond.
- 3. Sori in grooves between margin and costa.
- 4. Fronds almost terete apart from widened apical fertile part . . . . . **Nematopteris**
- 4. Fronds of about uniform width throughout . . . . . **Scleroglossum**
- 3. Sori more or less confluent near apex, not in grooves . . . . . **Oreogrammitis**
- 1. Fronds pinnately lobed to bipinnately lobed.
- 5. One vein (sometimes forked) and one sorus on each lamina-lobe.
- 6. Fertile lobes flat.
- 7. Sori superficial . . . . . **Xiphopteris**
- 7. Sori deeply sunk in submarginal pockets . . . . . **Prosaptia**
- 6. Fertile lobes partly reflexed, protecting the sori.
- 8. Lobes thin, only basiscopic margin reflexed . . . . . **Calymmodon**
- 8. Lobes coriaceous, both margins reflexed towards apex and enclosing the sorus . . . . . **Acrosorus**
- 5. Veins in lobes pinnately branched, each lobe with more than one sorus.
- 9. Sori superficial, or sunk in cavities perpendicular to the surface . . . . . **Ctenopteris**
- 9. Sori deeply sunk in submarginal pockets not perpendicular to the surface . . . . . **Prosaptia**

REMAINING GENERA OF FERNS

ADIANTUM Group

- 1. Water plants; sporangia borne singly and protected by reflexed edges of the lamina. . . . . **Ceratopteris**
- 1. Land plants; sporangia in sori or more or less acrostichoid.
- 2. Rigid hairs or bristles on rhizome and bases of stipes.
- 3. Fronds bipinnate, leaflets more or less lobed . . . . . **Cerosora**
- 3. Fronds simple or simply pinnate, or palmate with entire leaflets.
- 4. Veins anastomosing only near edge of lamina; fronds simple or palmate; paraphyses (if present) with distinctive apical cell . . . . . **Syngramma**
- 4. Veins anastomosing throughout lamina; fronds pinnate, trilobed or simple; paraphyses always abundant, hair-like, of many cells, apical one not different from the rest.
- 5. Sori broad, elongate, parallel to costa and edge, or more or less spreading along the veins. . . . . **Taenitis**
- 5. Sori in submarginal grooves, edges of grooves of equal thickness (*Schizoloma sensu COPEL.*). . . . . **Schizolepton**
- 2. Scales on rhizome and bases of stipes.
- 6. Lower surface of fronds covered with white or yellow powder.
- 7. Sori along whole length of veins on lower surface . . . . . **Pityrogramma**
- 7. Sori at ends of veins, protected by reflexed lobes of margin . . . . . **Cheilanthes**
- 6. Lower surface of fronds not covered with such powder.
- 8. Sori elongate (continuous or broken) along margins of lamina and protected by reflexed margin.
- 9. Fronds much dissected, the ultimate lamina-lobes small and connected by a narrow wing.
- 10. Fertile lobes much broader than sterile, the whole of each margin bearing a broad thin reflexed indusium . . . . . **Onychium**
- 10. Fertile lobes not much broader than sterile, reflexed margin not continuous along larger fertile lobes nor very broad . . . . . **Cheilanthes**
- 9. Fronds, if much branched, having quite distinct leaflets not joined by a wing.
- 11. Fronds simple and lobed, or deeply pinnatifid; sori quite continuous along edge . . . . . **Doryopteris**
- 11. Fronds branched with distinct stalked leaflets . . . . . **Pellaea**
- 8. Sori otherwise.
- 12. Sori elongate along all or most of the veins.
- 13. Fronds simple . . . . . **Hemionitis**
- 13. Fronds pinnate or bipinnate . . . . . **Coniogramme**
- 12. Sori otherwise.
- 14. Sori on lower surface, spreading a little along the veins . . . . . **Anogramma**
- 14. Sori at ends of veins.
- 15. Sori on surface of reflexed marginal flaps . . . . . **Adiantum**
- 15. Sori at ends of veins, sometimes more or less protected by reflexed marginal flaps . . . . . **Notholaena**

ASPLENIUM Group

- 1. Sori short, on one-veined ultimate segments of much-divided fronds . . . . . **Loxoscaphe**
- 1. Sori distinctly elongate along the veins; segments of frond usually with more than one vein.

2. Sori on adjacent veins opening towards each other, a raised line remaining between the sori when they are ripe . . . . . **Diplora**
2. Sori all facing the same way except in a few species which have simple fronds and then the raised line between adjacent sori lacking . . . . . **Asplenium**

#### ATHYRIUM Group

1. Veins free.
2. Groove of rachis open to admit grooves of branch rachises and midribs of leaflets.
3. At least some sori elongate along veins.
4. Sori not indusiate; fleshy outgrowths present at bases of pinnae on upper surface. **Cornopteris**
4. Sori indusiate; no such outgrowths.
5. Double sori (on both sides of a vein) not connected at their distal ends . . . **Diplazium**
5. Double sori (at least some of them) connected at their distal ends; usually some reniform and J-shaped sori present . . . . . **Athyrium**
3. Sori not elongate along veins . . . . . **Cystopteris**
2. Groove of rachis not open to admit grooves of branches . . . . . **Dryothyrium**
1. Veins anastomosing.
6. Sori almost circular, indusium reniform . . . . . **Anisocampium**
6. Sori elongate along veins.
7. Veins anastomosing regularly, about as in *Cyclosorus*; sori on nearly all veins of fertile frond. **Callipteris**
7. Veins anastomosing less regularly, the areoles adjacent to costae large; sori never so abundant.
8. Indusium rather firm, its edge reflexed at maturity . . . . . **Diplazium**
8. Indusium thin, sausage-shaped, breaking at maturity, its edge not reflexed . . **Diplaziopsis**

#### BLECHNUM Group

1. Sori not acrostichoid, or if apparently so, a thin indusium present all along edge of fertile leaflets.
2. Sori continuous along each side of the costa of a leaflet, a sterile lamina present beyond the sorus or not . . . . . **Blechnum**
2. Sori not continuous throughout length of a leaflet; one sorus to each areole along the costa.
3. Small ferns, simply pinnate; edges of pinnae sharply toothed . . . . . **Doodia**
3. Large ferns, at least bipinnatifid; edges of pinnae not sharply toothed . . . **Woodwardia**
1. Sori acrostichoid (no thin reflexed indusium on fertile leaflets) . . . . . **Brainea**

#### DAVALLIA Group

1. Rhizome bearing hairs and scales; marginal cells of scales bearing papillose outgrowths **Leucostegia**
1. Rhizome bearing scales only; marginal cells of scales not bearing papillose outgrowths.
2. Fronds simple.
3. Sori elongate along the margin, protected by continuous indusia . . . . . **Parasorus**
3. Sori singly at ends of veins.
4. Indusium attached at base only (or slightly above base) . . . . . **Humata**
4. Indusium attached along sides as well as base . . . . . **Scyphularia**
2. Fronds pinnately branched.
5. Fronds more or less copiously persistently hairy; lamina thin; indusium small, of various shapes. **Davallodes**
5. Fronds not hairy when mature.
6. Indusium attached along base and whole of sides.
7. Fronds trifoliate or simply pinnate with elongate narrow pinnae . . . . . **Scyphularia**
7. Fronds more copiously branched . . . . . **Davallia**
6. Indusium attached at base only, or also a little above the base, not along whole length of both sides.
8. Fronds much-branched, thin . . . . . **Araiostegia**
8. Fronds of various form, lamina coriaceous or fleshy.
9. Scales with long acicular tips . . . . . **Trogostolon**
9. Scales lacking long acicular tips . . . . . **Humata**

#### DENNSTAEDTIA Group

1. Sori in cups at ends of veins.
2. Rhizome slender, creeping, hairy . . . . . **Dennstaedtia**
2. Rhizome stout, erect, scaly . . . . . **Orthopteris**
1. Sori at ends of veins, variously protected, not in cups.
3. Sori lacking protection; glandular hairs mixed with sporangia . . . . . **Monachosorum**
3. Sori with indusium or covered when young by reflexed lobe of edge of lamina; no glandular hairs with sporangia.
4. Sori distinctly superficial, each at the end of a single vein and protected by an indusium which is

- pocket-shaped (attached by base and sides), opening towards margin . . . . . **Microlepia**
4. Sori more or less protected by reflexed edge (or lobes of edge) of lamina, with or without an inner indusium also.
5. Sori almost continuous along edges of lamina.
6. Veins anastomosing; no inner indusium . . . . . **Histiopteris**
6. Veins free; inner indusium present . . . . . **Pteridium**
5. Sori singly at ends of veins, or uniting a few veins, not continuous along all edges of lamina.
7. No inner indusium . . . . . **Hypolepis**
7. Inner indusium present . . . . . **Paesia**

**DICKSONIA Group**

1. Fertile leaflets distinctly narrower than sterile.
2. Fertile pinnules deeply lobed; massive tree-ferns . . . . . **Dicksonia**
2. Fertile pinnules not lobed; stem short, creeping . . . . . **Cystodium**
1. Fertile leaflets little different from sterile in size and shape.
3. Pinnules deeply lobed almost at right angles to costa, not pinnate . . . . . **Cibotium**
3. Pinnules pinnate, tertiary leaflets small, very oblique and lobed . . . . . **Culcita**

**DRYOPTERIS Group**

1. Fronds hairy as well as scaly on costae, costules and rachises; hairs septate, coarse, different from the scales.
2. Sorus when young spherical and quite enclosed by indusium which when ripe breaks to expose sporangia.
3. Sori on distinct stalks . . . . . **Peranema**
3. Sori sessile . . . . . **Diacalpe**
2. Sorus otherwise; indusium attached on basiscopic side of sorus.
4. Hairs sparse; scales broad and thin . . . . . **Acrophorus**
4. Hairs copious; scales thick, elongate . . . . . **Stenolepis**
1. Fronds scaly; no hairs as distinct from scales (some scales may be narrow and almost hair-like).
5. Pinnules jointed to rachis; sori longer than wide . . . . . **Didymochlaena**
5. Pinnules not jointed to rachis; sori not elongate.
6. Several vascular bundles in stipe.
7. Basal acroscopic leaflet or lobe of middle pinnae distinctly nearer to main rachis than basal basiscopic leaflet or lobe; fronds never simply pinnate.
8. Fronds elongate, basal pinnae not much enlarged on basiscopic side; rachis often bearing a bud. **Polystichum**
8. Fronds broadly deltoid, basal pinnae much enlarged on basiscopic side; rachis lacking buds. **Polystichopsis**
7. Basal acroscopic leaflet or lobe of middle pinnae not distinctly nearer to main rachis than basiscopic leaflet or lobe; or fronds simply pinnate throughout.
9. Indusium peltate; teeth on edges of lamina often with stiff slender points. . . . . **Polystichum**
9. Indusium reniform; teeth not so produced . . . . . **Dryopteris**
6. Two vascular bundles in base of stipe . . . . . **Gymnocarpium** and **Currania**

**LINDSAEA Group**

1. Fronds simply pinnate, veins free, pinnae numerous, spreading, jointed to rachis . . . . . **Isoloma**
1. Fronds otherwise.
2. Pinnae or lobes elongate, bearing many sori, each at the end of a single vein; lamina rather thick. **Tapeinidium**
2. Pinnae or lobes, if elongate, bearing a sorus connecting the ends of several veins; lamina thinner.
3. Fronds finely divided, the ultimate divisions small and connected with each other by wings; sori solitary at apices of ultimate divisions . . . . . **Sphenomeris**
3. Fronds variously branched; leaflets distinct, each with several sori or a more or less continuous marginal sorus . . . . . **Lindsaea**

**LOMARIOPSIS Group**

1. Rhizome short-creeping with fronds close together; epiphytes or rock-plants, not high-climbing.
2. Fronds always simple; stipes jointed to phyllopodia; veins free except near margin; usually epiphytes. **Elaphoglossum**
2. Fronds usually pinnate (if simple, veins much anastomosing); stipes not jointed to rhizome; usually rock-plants.
3. Veins free . . . . . **Egenolfia**
3. Veins anastomosing . . . . . **Bolbitis**
1. Rhizome high-climbing.
4. Veins free.

5. Pinnate or bipinnate, all pinnae and pinnules jointed at base (except on some bathyphylls).
6. Fronds of high-climbing part of plant simply pinnate (bathyphylls sometimes bipinnate); only two rows of fronds on rhizome (two meristeles in internodes) . . . . . **Teratophyllum**
6. Fronds of high-climbing part of plant usually bipinnate; more than two rows of fronds on mature rhizome (more than two meristeles in internodes) . . . . . **Arthrobotrya**
5. Pinnate; terminal leaflet not jointed at base.
7. Fertile pinnae fully acrostichoid . . . . . **Lomariopsis**
7. Fertile pinnae bearing separate exindusiate sori on small lobes at ends of veins. . . . . **Thysanosoria**
4. Veins anastomosing . . . . . **Lomagramma**

#### NEPHROLEPIS Group

1. Fronds pinnate, pinnae jointed to rachis.
2. Stipes jointed to rhizome or to outgrowths from rhizome . . . . . **Arthropteris**
2. Stipes not jointed to rhizome . . . . . **Nephrolepis**
1. Fronds simple . . . . . **Oleandra**

#### PLAGIOGYRIA Group

- Single genus . . . . . **Plagiogyria**

#### PTERIS Group

1. Sori marginal or submarginal, more or less elongate, protected by a reflexed indusium.
2. Rhizome scandent . . . . . **Lepidocaulon**
2. Rhizome not scandent.
3. Sorus along one edge of ultimate lobes of lamina . . . . . **Hemipteris**
3. Sorus along both edges of ultimate lobes.
4. Sori joining many veins, usually one sorus along each edge of a lobe of the lamina. . . . . **Pteris**
4. Sori short, often more than one on each edge of a lobe; fertile margin thickened . . . . . **Schizostege**
1. Sori acrostichoid.
5. Stock stout, erect; veins reticulate throughout; only distal pinnae fertile . . . . . **Acrostichum**
5. Rhizome slender, long-creeping or climbing; veins forming one series of narrow areoles by costa (seen near apex of leaflet); fertile fronds normally wholly fertile . . . . . **Stenochlaena**

#### TECTARIA Group

1. A tooth present in each sinus between lobes of lamina, the tooth not in the plane of the lamina.
2. Vascular bundles in stipes numerous, not in a simple ring; veins more or less anastomosing.
3. Veins anastomosing in a single series of costal and costular areoles . . . . . **Pleocnemia**
3. Veins more copiously anastomosing . . . . . **Arcypteris**
2. Vascular bundles in stipes in a simple ring; veins free . . . . . **Pteridrys**
1. No tooth present in sinuses between lobes of lamina.
4. Pinnae jointed to rachis . . . . . **Cyclopeltis**
4. Pinnae not jointed to rachis.
5. Fertile leaflets acrostichoid and very much contracted as compared with sterile ones.
6. Veins free; sterile frond much divided . . . . . **Psomiocarpa**
6. Veins anastomosing.
7. Fronds deltoid, the basal basiscopic lobe of basal pinnae largest . . . . . **Stenosemia**
7. Fronds otherwise, basal basiscopic lobes of basal pinnae not largest.
8. Fronds small, trifoliate; apical leaflet largest, commonly 5 cm long . . . . . **Quercifilix**
8. Fronds larger and in most cases more divided.
9. Sterile fronds simple to deeply pinnatifid, not truly pinnate . . . . . **Hemigramma**
9. Sterile fronds with at least one pair of free pinnae, usually several pairs . . . . . **Heterogonium**
5. Fertile leaflets not acrostichoid.
10. Two vascular bundles in base of stipe, uniting upwards to form a single bundle; scales confined to swollen bases of stipes . . . . . **Hypodematium**
10. More than two vascular bundles throughout length of stipe; scales not so confined.
11. Veins free.
12. Basal basiscopic vein of a vein-group springing from the costule.
13. Indusia peltate . . . . . **Dryopolystichum**
13. Indusia reniform or absent.
14. Fronds usually much longer than wide; basiscopic margin of lamina-lobes not thickened. . . . . **Ctenitis**

14. Fronds usually about as long as wide; basiscopic margin of lamina-lobes thickened.

Lastreopsis
12. Basal basiscopic vein of a vein-group springing directly from the costa.

15. Basal pinnae with basal basiscopic lobes longest

Tectaria

15. Basal pinnae with basal basiscopic lobes or pinnules shorter than middle ones.

Heterogonium
11. Veins anastomosing.

16. Sori large, indusiate, terminal on a free vein, the receptacle elongate, fertile fronds narrow.

Luerssenia

16. Sori various, indusiate or not, on free or netted veins; if indusiate, the receptacle not elongate, or fertile fronds not contracted as compared with sterile.

17. Basal pinnae deeply lobed, basal basiscopic lobe not largest; few free veins in areoles.

Heterogonium

17. Basal pinnae lobed or not; if lobed, basal basiscopic lobe largest; many free veins in areoles.

Tectaria

THELYPTERIS Group

1. Fronds bearing many buds on rachis

Ampelopteris
1. Fronds lacking buds.

2. Veins free (in some cases basal veins of adjacent groups just meet at the sinus).

Thelypteris

2. Veins anastomosing.

3. Sori elongate along veins.

4. No indusia.

5. Venation as in Cyclosorus; veins from adjacent costules uniting to form a single excurrent vein.

Stegnogramma

5. Venation irregularly anastomosing, often with additional enclosed areoles

Dictyocline

4. Indusia present

Sphaerostephanos

3. Sori not elongate, or slightly so if without indusia (*Abacopteris* FÉE, *Haplodictyum* PRESL).

Cyclosorus
- VITTARIA Group
1. Frond very small, with one vein only; sorus near apex, along the vein

Monogramma

1. Frond with lateral veins as well as a main vein.

2. Frond linear, sori one or more, on separate free branches, which run close to and parallel with main vein

Vaginularia

2. Fronds otherwise; veins anastomosing at least near the margin.

3. Sori linear, in marginal grooves or superficial and parallel to margin; veins forming one series of areoles, anastomosing only near the margin

Vittaria

3. Sori along veins, variously disposed; veins anastomosing copiously throughout the lamina.

Antrophyum
- MARSILEACEAE
- Sole genus

Marsilea
- SALVINIACEAE
1. Leaves less than 1 mm long, bilobed, with one lobe submerged

Azolla

1. Leaves at least 1 cm long, simple, floating with upper surface fully exposed

Salvinia
- XXI

## 7. BIBLIOGRAPHY

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## GLEICHENIACEAE (R. E. Holttum, Kew)

Rhizome relatively slender, creeping, protostelic (solenostelic only in *Dicranopteris pectinata* (WILLD.) UND. of tropical America), in *Stromatopteris* bearing erect irregularly dichotomous branches which bear the fronds, in all other cases bearing fronds directly; young parts covered with peltate fringed scales (scales otherwise in *Stromatopteris*) or branched hairs. *Fronds* unbranched in *Stromatopteris*, in all other cases branched in fully developed plants, the main rachis bearing a series of pairs of branches, its apex periodically dormant while each successive pair of branches develops; each primary branch often bearing a pair of secondary branches and a permanently dormant apex between them, the process sometimes repeated several times; ultimate branches either bipinnatifid or pinnatifid, the lamina (whether of an ultimate branch, or leaflet of an ultimate branch) cut almost to the costa; veins in lamina-segments pinnate, branches simple or forked, free (in some cases apparently joining a thickened non-vascular margin). *Sori* of 2–15 or more sporangia, attached to a small receptacle on the surface of a vein (except in *Stromatopteris*, where each sorus is spread along part of both branches of a forked vein), never at the end of a vein, all sporangia in one sorus developing simultaneously; branched hairs or scales often present with sporangia but no indusium. *Sporangia* with complete oblique annulus, dehiscing vertically, containing c. 200–800 or more spores. *Spores* monoletate or trilete, smooth, translucent, colourless.

*Gametophyte* (not known in *Stromatopteris*) at first cordate, then ribbon-like with heavy midrib, finally branching at apex; rhizoids stiff, abundant, usually reddish-brown; two-celled glandular hairs developed by many species in association with archegonia and also on margin; antheridia comparatively large and complex in structure (some more so than others); archegonia with long necks (longest in *Gleichenia* subg. *Gleichenia*) directed towards apex of prothallus; no cases of apogamy observed.

**Distribution.** Throughout the wetter parts of the tropics and subtropics, and in south temperate regions. Three genera: *Stromatopteris* (monotypic, in New Caledonia), *Gleichenia* (3 subgenera, c. 150 species, in the tropics mainly on mountains, at lower altitudes in southern temperate regions), and *Dicranopteris* (2 subgenera, c. 10 species, mainly tropical, at low and moderate altitudes). *Dicranopteris* is much more polymorphic in Malaysia than in any other part of the tropics. (The genus *Platyzoma* is excluded from the family; see HOLTTUM in Kew Bulletin no 3, 1956, p. 551).

**Fossils.** The fragmentary nature of the earlier fossils ascribed by various authors to the family makes judgment upon them difficult. The form and arrangement of sporangia is the best criterion; on this basis paleozoic fossils named *Oligocarpia* have been assigned to *Gleicheniaceae*, but they do not always show details of structure of the individual sporangia clearly. Some have been found on fronds of the *Pecopteris* type (not unlike *Gleichenia* of today), some on the rather different *Sphenopteris*, but none show pseudo-dichotomy of the kind now universal in the family. It may be that some of these fossils represent members of the family before periodic growth and pseudo-dichotomy developed.

*Gleichenia gracilis* ZIGNO, from the Jurassic of northern Italy, has been more confidently referred to the family by paleobotanists; but the main branches of the frond are not opposite, and the irregular forking of the smaller branches looks more like true dichotomy than pseudo-dichotomy (judging from ZIGNO's figure); there are no sori.

Wealden fossils from Belgium show anatomical structure of rhizome and petioles as in living *Gleichenia*. In somewhat later Cretaceous rocks of various parts of the world, but especially in West Greenland, are fossils which show every character (except scales, which have not been seen) of existing members of *Gleichenia* subg. *Diplopterygium* (HEER, Flora Fossilis Arctica, III) and some are very like subg. *Gleichenia*, with more or less transitional stages between the two conditions which are not shown by living members of the family. Some of them show permanent dormancy of a lateral branch of a frond, but none show the condition either of *Gleichenia* subg. *Mertensia* or of *Dicranopteris*, which have what I regard as the most highly developed forms of branching. Some Greenland fossils show many sporangia in a sorus, a character not shown by any living member of the family having similar leaf-form, and TUTIN (Ann. Bot. Lond. 46, 1932, p. 503–508) has described *Gleicheniopsis* with numerous small

sporangia each containing less than 32 spores; the latter were not attached to any forked axis.

The only fossil known to me which corresponds in leaf-form with *Dicranopteris* is *Gleichenia hantonensis* WANKLYN from Eocene beds at Bournemouth (southern England). This was the subject of a reconstruction, copied by other authors, by GARDNER and ETtingshausen (British Eocene Flora, I fig. 28) which (on the same frond as typical *Dicranopteris* ultimate branches) incorporated accessory branches as in living *D. linearis* (not shown in the fossils) and also some curious hook-bearing leaflets which are associated with the *Dicranopteris* fossil leaflets but nowhere attached to them. Disregarding these unwarranted additions, *Gleichenia hantonensis* agrees with *Dicranopteris* in branching, venation and sori (position, shape and number of sporangia); if hairs could be found, agreement with *Dicranopteris* would be complete. The Greenland and Bournemouth fossils offer evidence hard to reconcile with COPELAND's opinion that the family is of antarctic origin (Genera Filicum, p. 26).

**Ecology.** All species are sun-ferns, and most form thickets, to which they are adapted by their creeping rhizomes, and by the indefinite growth in length of the fronds (at least in the wet tropics). Periodic dormancy of the apex of the main rachis permits periodic upward growth of the rachis-apex, unencumbered by branches; it may thus pass between any other leaves or branches which may be above it, and then develop its new pair of leafy branches in a fully exposed position while the apex itself is again dormant. The most efficient members of the family from this standpoint are species of *Dicranopteris* and of *Gleichenia* subgen. *Mertensia*, because by repeated forking their lateral branch-systems produce a spreading fan-shaped arrangement, but it is notable that in *Dicranopteris* a reversion to an effectively pinnate form of branching has occurred, seen at its full development in *D. speciosa* (Pr.) HOLTT.

Most members of the family are pioneer plants, establishing themselves on bare ground, sometimes in fully exposed places, talus, earthslides, precipices, rocks (fig. 3), steep ridges (fig. 2, 10), often on poor rocky or leached soils. Prothalli (which are often very abundant) need a little shelter, but a young sporophyte can quickly spread by means of its rhizome, and *Dicranopteris linearis*, for example, can grow in places where few other plants can establish themselves. A *Dicranopteris* thicket, once formed, can persist for a long time (fig. 11, 13), unless tree seedlings have established themselves in it at an early stage (shade of trees weakens or kills *Dicranopteris* plants unless they can climb); such thickets have been greatly encouraged by man-made clearings of forest. On the edge of forest, some of the larger members of the family can climb to a considerable height.

At high altitudes on mountains, where slower-growing alpine scrub occurs, smaller species of the family are often abundant and form lower thickets. They may grow in association with *Sphagnum*, or in dry rocky places. An important character is that their demands of mineral substances are small.

**Vegetative morphology.** *Stromatopteris* is peculiar in its erect rhizome-branches, in its scales and hairs, and in having sori spread along both branches of a vein. NAKAI (Bull. Nat. Sc. Mus. Tokyo n. 29, 1950) has proposed its separation as a distinct subfamily, and I consider this separation fully justified. The genus does not occur in Malaysia. It is probably to be regarded as a reduced relic of an otherwise extinct group.

As above noted (under Ecology), the fronds of other members of the family are all branched (except in young or stunted plants), the branching being pinnate in plan, with dormancy, either periodic or permanent, of apices of various orders. Fig. 1, 7, 12. The branch-patterns are in some cases complex, and are characteristic in the different genera and subgenera (for a comparative account, see HOLTTUM, Phytomorphology 7, 1957, 168-184). FILARSKY attempted a detailed analysis of these branch-patterns (Ann. Hist.-Nat. Mus. Nat. Hungarici 20, 1923, 1-23; *ibid.* 21, 1924, 163-170) but the results seem to me confused. He did not distinguish clearly between *Dicranopteris* and *Gleichenia* subgen. *Mertensia* of the present treatment, nor between *Platyzoma* and *Gleichenia* subgen. *Gleichenia*. The form of branching shown in his fig. 12 and 24 is one I have never seen (shorter branches on the same side at successive unequal forkings).

The major divisions of the family are also distinguished by their dermal appendages. Those of *Stromatopteris* are quite peculiar (scales, only on rhizome, not peltate, and long simple hairs also on rhizome). The rest of the family have either fringed peltate scales and stellate hairs with unicellular rays (*Gleichenia*) or branched hairs of complex structure, true scales being absent (*Dicranopteris*, fig. 14).

The venation in *Gleichenia* is pinnate in each segment of the lamina, lateral veins being forked (fig. 8c) except in subgen. *Gleichenia* (where the area of the segment is very small). In *Dicranopteris* the lateral veins are at least twice forked. Fig. 15a, c. The sori are always attached on the surface of a vein, the sporangia attached to a small raised receptacle. In *Gleichenia* subgen. *Gleichenia* the veins are very short, and are not visible unless the lamina is cleared; in many taxonomic works the sori are said to be terminal on the veins in this subgenus, but cleared specimens show that they are not. The arrangement of sporangia in a sorus, in both genera, has been discussed and illustrated by BOWER (The Ferns, vol. 2, 203-206, fig. 476, 486-489). In some species of *Gleichenia* subgen. *Gleichenia* the sori are in depressions in the substance of the lamina (e.g. *G. peltophora* COPEL.); in others they are protected by the reflexed margins of the lamina and by outgrowths of tissue from the costa (*G. vulcanica* BL., fig. 1d-e). NAKAI (*l.c.*), following PRESL, attempted to use these characters to establish separate genera, but the species *G. microphylla* R.Br. is intermediate.

**Sporangia and spores.** The structure of sporangia has been fully described by BOWER (*l.c.*). Both trilete and monolete spores occur in the family. NAKAI (*l.c.*) proposed a basic division of the family

on spore-form, but in so doing he supposed that only trilete spores occur in his restricted genus *Dicranopteris* (*D. linearis* and its near allies); in fact closely related species of this group have spores of different forms, and a division of the family on spore-form is certainly unnatural.

**Gametophyte.** The most recent and most complete account of gametophytes in the family is by A. G. STOKEY (Bull. Torrey Bot. Club 77, 1950, 323-339) and includes references to earlier accounts. Species of all genera and subgenera here recognized were studied. Dr STOKEY's conclusion is that the gametophyte in all cases shows many primitive characters, but there is little significant difference within the family to indicate that one part is more primitive than the rest. *Gleichenia* subg. *Gleichenia* shows specialized characters (notably the long neck of the archegonium) and on characters of the gametophyte is judged to be further removed from the rest of the family than they are from each other. Two-celled hairs of a peculiar nature have an origin similar to that of the larger hairs on prothalli of *Cyatheaceae*; apart from these hairs, the prothalli of *Gleicheniaceae* most resemble those of *Dipteris*.

**Cytology.** MANTON & SLEDGE (Phil. Trans. Roy. Soc. B, 238, p. 143, pl. 4) report for *Dicranopteris linearis* from Ceylon both  $n = 39$  and  $n = 78$ ; from Singapore, for what is now recognized as *D. curranii* COPEL.,  $n = 39$ . MANTON reports verbally that a plant of *D. linearis* sent from Singapore and cultivated at Kew is a sterile triploid hybrid. MEHRA & SINGH also report  $n = 39$  for *D. linearis* from Northern India (Curr. Sc. 25, 1956, 168), and  $n = 56$  for *Hicriopteris glauca* (probably *Gleichenia gigantea* WALL., which is the common Himalayan species of this group), a species of *Gleichenia* subg. *Diplopterygium*. BROWNLIE (Trans. R. Soc. N.Z. 85, 1958, 213-214) reports  $n = 20$  for *G. (subg. Gleichenia) microphylla* R. BR. and  $n = 34$  for *G. (subg. Mertensia) cunninghamii*. T. G. WALKER reports (personal communication)  $n = 34$  for two species of subg. *Mertensia* from Jamaica.

**Anatomy.** The rhizome has a simple protostelic structure except in *Dicranopteris pectinata* (see BOWER, l.c.). The rachis has a single C-shaped vascular strand; all the outer tissues in the rachis are thick-walled and when mature form a very strong protection for the vascular strand. Such protection is important in fronds which continue to grow in length for a long period.

**Economic importance.** HEYNE (Nutt. Pl. N.I. 1927, p. 97) records the following uses for parts of plants of this family; the chief species used are *Dicranopteris linearis* and *D. curranii*. The rachises of mature fronds are tied into bundles and the bundles used in making the fences of a certain kind of fish trap; they will last two years when immersed in sea-water. Parts of the rachis of a large frond (the largest are produced by *D. curranii*) when suitably split make excellent pens for writing Arabic characters (I learned of this use also in Singapore). The vascular strands of stipe and rachis are separated and used for special kinds of fine plaited work, being strong and pliable.

*Dicranopteris* thickets may be useful as preventing erosion, but they are troublesome to the forester when they prevent regeneration of tree-seedlings in forest clearings. As the rhizomes are almost or quite superficial, they are exposed when the thicket is cut down, and usually one such cutting is enough to kill almost all of the plants. Fronds are sometimes cut — when in absence of other suitable material — to provide light shade for transplanted seedlings.

**Taxonomy.** I published a statement on taxonomy, with discussion of the present arrangement, in 1957 (Reinwardtia 4, p. 257-280). COPELAND (Gen. Fil. 1947) divided the Malaysian members into four genera. It seems to me, however, that *Dicranopteris* is so different from the rest that a main division should indicate this difference, and I therefore recognize two genera, *Gleichenia* and *Dicranopteris*, the former with three subgenera which correspond to COPELAND's genera. For one of the latter he used the name *Hicriopteris* PRESL, but the type species of that genus is a *Dicranopteris* (described as *D. speciosa* in the present work). I have therefore adopted the subgeneric name *Diplopterygium*, first proposed (as a sectional name) for this group of ferns by DIELS (in ENGLER & PRANTL, Pfl. Fam. 1, 4, p. 350-356). For the other subgenus the name *Mertensia* is available; it was first used in this rank by HOOKER, though with a larger content. This name was first proposed by WILLDENOW in 1804 as a generic name to cover all known members of the family with larger divisions of the lamina than the original *G. polypodioides* (THUNB.) SMITH; but as a generic name it was antedated by *Mertensia* ROTH (*Boraginaceae*) and so it is illegitimate. In 1806 BERNHARDI published the generic name *Dicranopteris*, citing under it only one species of *Mertensia* WILLD., viz *Polypodium dichotomum* THUNB., which thus becomes the type species of *Dicranopteris*. I have typified *Mertensia* by the species *M. truncata* WILLD. (Reinwardtia 4, 1957, 261). Both *Mertensia* and *Dicranopteris* are used here in a more restricted sense than intended by some earlier authors. COPELAND used the generic name *Sticherus* PRESL for subg. *Mertensia* of the present account. This name was established by PRESL for two species of which he had seen no specimens, with a brief and confused description, and the lapse of the name is not to be regretted.

#### KEY TO THE GENERA

1. Young parts of plants protected by fringed peltate scales and stellate hairs. Sori of 2-5 sporangia. Veins simple or once forked . . . . . 1. *Gleichenia*
1. Young parts of plants protected by branched hairs of various form, scales lacking. Sori of 8-15 or more sporangia. Veins forked at least twice . . . . . 2. *Dicranopteris*

## 1. GLEICHENIA

SMITH, Mem. Ac. Turin 5 (1793) 419, *non* NECK. 1790, *nom. cons.* — *For synonyms see the subgenera.*—**Fig. 1-10.**

*Rhizome* dichotomously branched, protostelic, near the apex protected by peltate scales. *Fronds* of mature plants of indefinite growth in length (except sometimes at high altitudes), bearing *primary branches* in pairs, the apex of the main rachis dormant during the development of each pair of primary branches, the dormant apex in some cases protected by a pair of stipule-like leaflets of distinctive form (such *stipular leaflets* less often present in conjunction with dormant apices of lateral branch-systems); primary branches often each bearing a pair of *secondary branches* with a usually dormant apex between them, the process sometimes repeated to produce ultimate branches of fourth or fifth orders; dormant apices protected by peltate scales which (with two exceptions) are fringed by outgrowths from the marginal cells; *ultimate branches* either simply pinnatifid or bipinnatifid; *lamina* in all cases lobed almost to the costa, the veins in each segment pinnately branched; lateral veins simple or once forked; costae, costules and veins when young protected by small fringed peltate *scales* and by stellate hairs, sometimes glabrescent when mature; *sori* one or several to each segment of the lamina, upon the lateral veins, not terminal upon them (on the acroscopic branch of a forked vein), exindusiate, each consisting of 2-5 large *sporangia*; *paraphyses*, in the form of small stellate hairs or small scales with long marginal hairs, often present with the sporangia; annulus complete and oblique, dehiscing dorsally. *Spores* monolete or trilete, smooth and translucent, 256 or more in each sporangium.

## KEY TO THE SPECIES

1. Ultimate branches (branches on each side of an ultimate dormant apex) bipinnatifid.
2. Segments of the lamina not much longer than wide; one sorus on each segment. (*subg.* **Gleichenia**).
3. Fully developed pinnule-lobes not deeply concave beneath (the edges only slightly revolute).  
Tissues adjacent to costa not swollen. Sporangia when young in a circular depression in the lamina.
4. Edge of depression occupied by sorus distinctly raised. Small scales on lower surface of lamina.
  1. **G. peltophora**
4. Edges of depression occupied by sorus not raised. No small scales on lower surface of lamina.
  2. **G. microphylla**
3. Fully developed pinnule-lobes deeply concave beneath, the distal edges strongly revolute. Tissue adjacent to the costa more or less swollen. Sporangia not in a depression in the lamina.
5. Costae persistently scaly; tissue adjacent to the costa slightly swollen. Sporangia often 3.
  3. **G. vulcanica**
5. Costae of fully developed fronds usually quite glabrous; tissue adjacent to the costa much swollen. Sporangia 2.
  4. **G. dicarpa**
2. Segments of the lamina elongate, the costule bearing several forked veins, each of which may bear a sorus on its acroscopic branch. (*subg.* **Diplopterygium**).
6. Scales on dormant apex of rachis entire, to 10 by 3 mm. Segments of lamina at *c.* 45° to costae.
  5. **G. laevis**
6. Scales on dormant apex of rachis fringed with hairs or setae, or with a broad translucent margin. Segments of lamina almost at right angles to costae.
7. Scales on dormant apex of rachis 1 mm wide or more, edges fringed with spreading hairs to 0.5 mm long, or with translucent edge bearing fine short hairs.
8. Rachis-branches persistently quite covered with scales, or with a mixture of scales and hairs, on lower surface.
9. Rachis-branches covered almost entirely with thin brown scales 4-5 mm long and nearly 1 mm wide, stellate hairs few.
  6. **G. paleacea**
9. Rachis-branches covered with a dense felt of stellate hairs, and also with  $\pm$  abundant scales.
  10. Pinnules commonly 12-16 by 2-2½ cm. Upper surface of the lamina not swollen between the veins. Stipular leaflets present.
    7. **G. volubilis**
  10. Pinnules commonly 6-9 by 0.9-1.3 cm. Upper surface of the lamina much swollen between

- the veins. No stipular leaflets . . . . . 8. *G. bullata*
7. Rachis-branches not persistently quite covered with scales nor with a felt of stellate hairs on the lower surface.
11. Very few persistent scales on the lower surface of rachises and costae. Pinnules to 22 by 3.5 cm. 9. *G. longissima*
11. Many persistent dark scales on rachises and costae. Pinnules to 12 by 2 cm 10. *G. clemensiae*
7. Scales on dormant apex of rachis narrower, their edges bearing short stiff oblique setae.
12. Segments of the lamina near base of each pinnule constricted at the base (*i.e.* widening just a little above the constriction), joined together by a very narrow wing of even width along the costa.
13. Many such segments (20 or more pairs) on each pinnule.
14. Lamina rigid; segments of lamina  $2\frac{1}{2}$  mm wide; scales of dormant apex uniformly dark brown 11. *G. angustiloba*
14. Lamina thin; segments of lamina  $3\frac{1}{2}$  mm wide; scales of dormant apex pale with dark edges. 13. *G. deflexa*
13. Few (at most 7-8) such segments on each pinnule.
15. Pinna-rachises more or less persistently scaly; costules  $3\frac{1}{2}$ - $4\frac{1}{2}$  mm apart. 14. *G. sordida*
15. Pinna-rachises sparsely scaly, soon glabrous; costules  $5\frac{1}{2}$ -7 mm apart. 12. *G. elmeri*
12. Segments of lamina near base of each pinnule not thus constricted (or not more than one segment on the largest pinnules).
16. Stipular leaflets having lobes similar to pinnule-segments, not narrow and acuminate. Scales on rachis-apex not dark-fringed . . . . . 15. *G. norrisii*
16. Stipular leaflets having very narrow acuminate lobes quite different from normal segments of pinnules. Scales on rachis-apex dark-fringed.
17. Distal half of each rachis-branch strongly zig-zag, the pinnules deflexed so that each is in line with the part of the rachis beyond it . . . . . 16. *G. matthewii*
17. Distal half of each rachis-branch not thus zig-zag.
18. Pinnules c. 10 by 2 cm. . . . . 17. *G. brevipinnula*
18. Pinnules commonly 20 by 3-4 cm.
19. Dark rigid stellate hairs abundantly persistent on the lower surface of veins and lamina. 18. *G. blotiana*
19. Stellate hairs light brown, not abundant nor persistent on the lower surface of veins and lamina . . . . . 19. *G. conversa*
1. Ultimate branches simply pinnatifid. (*subg.* *Mertensia*).
20. Stipule-like leaflets, different from ordinary segments of the lamina, present at the branchings of the main rachis (on fronds of mature size).
21. Segments of lamina at right angles to the costa, or more or less deflexed. Lower surface not conspicuously glaucous.
22. Segments of lamina deflexed (lower ones much so), thick, with edges much revolute when dry. Main rachis-branches once or twice forked . . . . . 20. *G. reflexipinnula*
22. Segments of lamina not or little deflexed. Main rachis-branches often more than twice forked.
23. Forkings of rachis-branches equal or nearly so, not alternately unequal with larger branches at successive forks forming almost a straight line.
24. Scales on costules very abundant, spreading so as almost to cover the lower surface of the lamina. Veins on lower surface strongly raised . . . . . 21. *G. venosa*
24. Scales on costules not persistently covering the lower surface of the lamina. Veins not strongly raised . . . . . 22. *G. truncata*
23. Forkings of rachis-branches unequal, the larger branch at successive forks alternately to left and right, axes of these larger branches in almost straight line. . . . . 23. *G. milnei*
21. Segments of lamina distinctly oblique-ascending. Lower surfaces distinctly glaucous.
25. Primary branch-systems 5 times forked on large fronds, branches of all orders except the first leafy; no stellate hairs on the lower surface of veins . . . . . 24. *G. oceanica*
25. Primary branch-systems twice forked; stellate hairs (or at least their bases) persistent on the lower surface of veins . . . . . 25. *G. erecta*
20. Stipule-like leaflets absent (sometimes present in *G. loheri* var. *major*).
26. Margins of segments of lamina not distinctly toothed.
27. Only the ultimate branches fully leafy (penultimate without lamina or with some scattered segments).
28. Ultimate branches to 20 cm long. . . . . 26. *G. pulchra*
28. Ultimate branches 30-40 cm long.
29. Segments of the lamina to 25 mm long, costules  $5\frac{1}{2}$ -6 mm apart. Primary rachis-branches usually 3 times forked . . . . . 27. *G. pseudoscandens*
29. Segments of lamina to 17 mm long, costules 4 mm apart. Primary rachis-branches usually twice forked . . . . . 28. *G. alstonii*
27. At least the penultimate branches fully leafy, lower ones sometimes also.

30. Lamina-segments rarely more than twice as long as the distance between bases of adjacent costules.
31. Segments 8–12 mm long, costules 4–5 mm apart. Rachis-branches of 1st and 2nd orders 3–4 cm long. Scales on the main rachis-apex brown, more than 1 mm wide at base; scales on the costae rusty brown . . . . . 29. *G. vestita*
31. Segments 3–6 mm long, costules 3 mm apart. Rachis-branches of 1st and 2nd orders 1–2 cm long. Scales on the main rachis-apex very dark, narrower; scales on the costae dark at base, paler distally . . . . . 30. *G. bolanica*
30. Lamina-segments much more than twice as long as the distance between adjacent costules.
32. Scales on the costae only a few cells wide at the base, about half their length consisting of a hair, these hairs crisped and entangled . . . . . 31. *G. hispida*
32. Scales on the costae with short hair-points, their bases wider and their apices not entangled.
33. Costules at 60°–70° to costae . . . . . 25. *G. erecta*
33. Costules at almost a right angle to the costae.
34. Ultimate branches 25–45 cm long, 3–4½ cm wide; costules on ultimate branches 4–5 mm apart . . . . . 32. *G. brassii*
34. Ultimate branches smaller, costules on ultimate branches 3–4 mm apart. 33. *G. loheri*
26. Margins of the segments of the lamina distinctly toothed, at least towards the apex.
35. Margins toothed almost to base of segments. Costules at c. 45° to costae. 34. *G. flabellata*
35. Margins toothed only near apex of segments. Costules at wider angle to costae. 35. *G. hirta*

### 1. Subgenus *Gleichenia*

HOLTT. Reinwardtia 4 (1957) 262.—*Calymella* PRESL, Tent. Pterid. (1836) 48; CHING, Sunyatsenia 5 (1940) 287; NAKAI, Bull. Nat. Sc. Mus. Tokyo n. 29 (1950) 40.—*Gleicheniastrum* PRESL, Abh. (K.) Böhm. Ges. Wiss. M.-N. Cl. 5 (1848) 338; NAKAI, l.c. 42.—*Gleichenia* subg. *Eugleichenia* DIELS in E. & P. Pfl. Fam. 1, 4 (1900) 355.—*Gleichenia*; COPEL. Gen. Fil. (1947) 26.—Fig. 1–3.

Young plants first producing determinate bipinnatifid fronds, the largest of these as large as the branches of later fronds and sometimes fertile (plants in exposed places at high altitudes sometimes producing only fronds of this kind); then *fronds* bearing pairs of primary branches like the fronds of the first stage; in some cases the primary branches bearing one or more pairs of determinate bipinnatifid secondary branches, or the secondary branches leafless and bearing pairs of tertiary branches, the ultimate branches always determinate and bipinnatifid. *Leaflets* of bipinnatifid fronds or of ultimate branches lobed almost to the costa, lobes hardly longer than wide; veins in each lobe pinnately branched but without a conspicuous costule, lateral veins simple. One *sorus* on each lobe, upon the basal acroscopic vein, superficial or sunk in the substance of the lamina.

Distr. About 10 *spp.* in tropical and southern Africa, the Mascarene Islands, Malaysia and Australasia (not in Ceylon and India).

Ecol. In Malaysia only on mountains, in exposed places, usually in sandy or acid, peaty soils, sometimes in association with members of the other subgenera.

1. *Gleichenia peltophora* COPEL. Philip. J. Sc. 40 (1929) 292, t. 1.—*G. circinnata* var. *borneensis* BAK. J. Bot. 17 (1879) 37.—*G. borneensis* C. CHR. Gard. Bull. S. S. 7 (1934) 211.—*Calymella borneensis* CHING, Sunyatsenia 5 (1940) 288.

#### var. *peltophora*.

Rhizome-scales ovate, dark, entire. Determinate bipinnatifid *fronds* to 40 cm high (including stipe), often fertile; branched fronds bearing 1 or few pairs of branches; primary branches bipinnatifid-determinate or once forked with a permanently dormant apex in the fork, the primary branch always bearing leaflets (where primary branches are not forked, the main rachis may be leafy below junction with branches); *scales* on resting apex of rachis to 1½ by 1 mm, ovate, entire, convex,

shining, very dark brown with narrow pale edge; similar but smaller scales scattered on lower surfaces of rachises and less abundantly on costae; ultimate branches 20–30 cm long, bearing many *leaflets*, costae of adjacent leaflets 4–6 mm apart; leaflets 2–5 cm long, 2½–4 mm wide; lobes c. 1½ mm wide at base, gradually narrowed to rounded apex, edges slightly reflexed, lower surface slightly concave, glaucous, bearing scattered circular scales 0.2–0.3 mm diameter. *Sori*, if present, each sunk in a circular depression in the substance of the lamina, the lower surface of the lamina somewhat raised round the edge of the depression which occupies about half the width of the base of a lobe.

Type: Copeland s.n., 1 May 1917, Mt Matutum, Mindanao, 1600 m (H. Copel.).



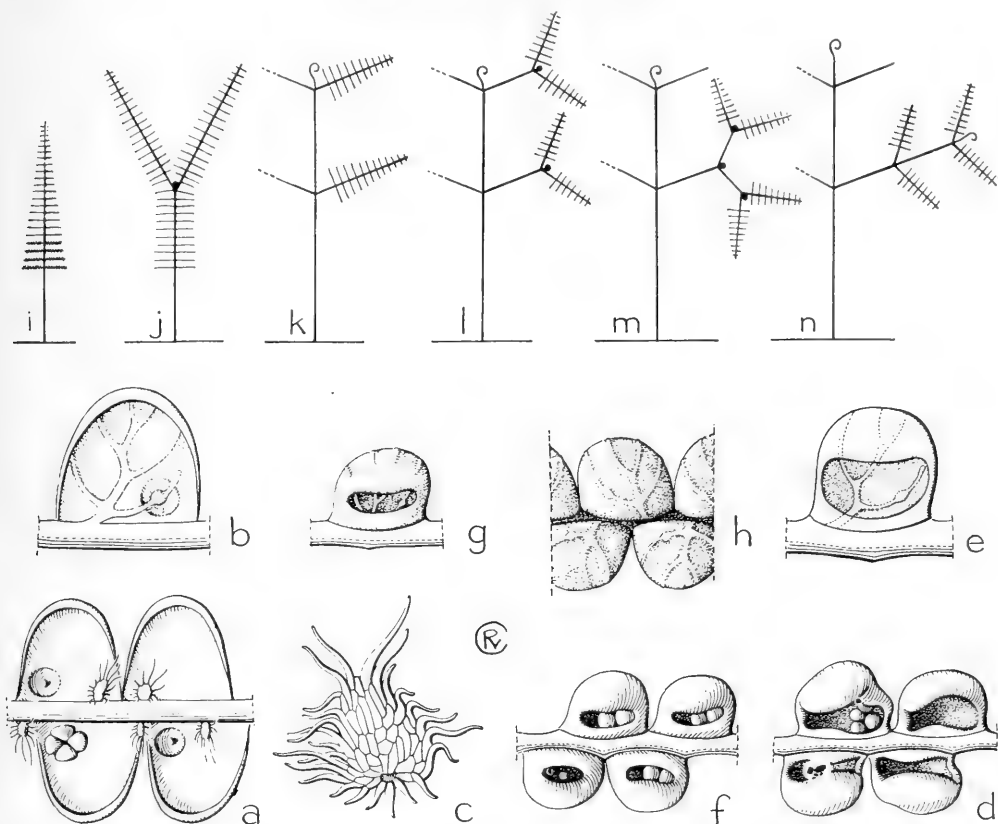


Fig. 1. *Gleichenia microphylla* R. BR. a. Lower surface of part of a pinnule, showing one mature sorus, and two soral depressions from which sporangia have been removed,  $\times 10$ , b. one lobe of lamina, cleared to show veins and position of sorus,  $\times 13$ , c. a scale,  $\times 50$ . — *G. vulcanica* BL. d. Part of pinnule from below (scales removed),  $\times 10$ , e. same cleared to show veins and position of sorus,  $\times 13$ . — *G. dicarpa* R. BR. f. Lower surface of part of pinnule,  $\times 10$ , g. same cleared to show veins,  $\times 13$ , h. upper surface of cleared pinnule showing position of sori. — Diagrams of various stages of branching which may occur during development of a single plant of *G. vulcanica* BL., i. First stage: plants in exposed places or at high altitudes may never develop further, j. transition stage, k. primary branches simple (corresponding to condition of subg. *Diplopterygium*), l. primary branches once forked, m. primary branches twice forked, n. primary branch proliferous beyond the first fork.

Distr. *Malaysia*: N. Borneo (Mt Kinabalu), Philippines (Mindanao), South Central Celebes, West New Guinea (several localities).

Ecol. In open places on mountain summits or high ridges, 1500–2500 m; on Mt Kinabalu in association with *G. vulcanica* and *Dipteris novoguineensis* POSTH.

var. *schizolepis* C. CHR. ex HOLT. Reinwardtia 4 (1957) 262.

Scales on rhizome short-fringed; scales on costae bearing a few rigid dark brown marginal hairs; scales on lower surface of lamina replaced by dark red-brown stellate hairs; fronds of the only specimen unbranched, with leaflets  $2\frac{1}{2}$  cm long, sterile.

Distr. Borneo (Sarawak: Mt Murud), 2500 m, once found.

2. *Gleichenia microphylla* R. BR. Prod. (1810) 161; v. A. v. R. Handb. Suppl. (1917) 80, incl. var. *semivestita* v. A. v. R. — *G. semivestita* LABILL. Sert. Austro-Cal. (1824) 8, t. 11. — *Calymella microphylla* PRESL, Tent. Pter. (1836) 49. — *Gleicheniastrum microphyllum* PRESL, Abh. (K.) Böhm. Ges. Wiss. M.-N. Cl. 5 (1848) 338; NAKAI, Bull. Nat. Sc. Mus. Tokyo n. 29 (1950) 45, incl. var. *semivestitum* NAKAI. — *Calymella circinnata* (? *G. circinnata* SW.) CHING, Sunyatsenia 5 (1940) 288. — *Calymella semivestita* CHING, l.c. — *Gleicheniastrum lowei* NAKAI, Bull. Nat. Sc. Mus. Tokyo n. 29 (1950) 44. — Fig. 1a-c, 2.

Rhizome to 3 mm diameter, the young parts covered with narrow dark brown rigid fringed scales. Fronds on young plants bipinnatifid, determinate, rarely fertile, on old plants usually



Fig. 2. *Gleichenia microphylla* R. Br. on edge of dwarf forest on wet sandy soil near summit of Kedah Peak, Malaya, 1200 m (HOLTUM, 1953).

branched, the primary branches sometimes forked with leaflets below the fork, rarely proliferous beyond the fork and then not bearing leaflets below the fork; secondary branches sometimes also forked. *Scales* on resting apices of rachis narrow, very dark, with pale thin marginal hairs towards the base and rigid dark setae near apex; rachises and costae more or less densely clothed with very small dark scales, their edges bearing rigid concolorous setae. Ultimate branches 12–25 by 4–5 cm; leaflets 7–9 mm apart,  $2\frac{1}{2}$ –4 mm wide; lobes of *lamina* 1–1.8 mm long, 0.7–1.5 mm wide at the base, apex rounded, edges usually a little reflexed; lower surface slightly concave, not glaucous. *Sorus* (if present) at first embedded in a circular cavity which occupies half the width of the lobe, edges of cavity not raised; sporangia 3–4 (rarely 5), surrounded by brown hairs not longer than the ripe sporangia.

Type: Robert Brown, Port Jackson, N.S. Wales (BM; dupl. at K).

Distr. From Annam through Malaysia to Australia, New Caledonia, and New Zealand; in *Malaysia*: Sumatra, Malay Peninsula, Lingga Arch., Borneo, and Moluccas (Ambon).

Ecol. In open places in sandy or thin peaty soil on summits or exposed ridges of mountains at 750–1800 m, especially on sandstone. At Fraser's Hill, Malay Peninsula, 1250 m, this species occurs in open places on a quartzite ridge, not on the neighbouring granite; it occurs on the summits of some isolated granite mountains (Mt Ophir, G. Belumut). It is abundant from 1000 m upwards in open *Leptospermum* forest, with *Sphagnum*, in thin peaty soil on the sandstone mountain G. Jerai or Kedah Peak.

Note. For a note on the type specimen of *G. circinnata*, see note under 4. *G. dicarpa*.

**3. *Gleichenia vulcanica* BL.** En. Pl. Jav. (1828) 251; RACIB. Fl. Btzig 1 (1898) 10; v. A. v. R. Handb. (1909) 56; BACKER & POSTH. Varenfl. Java (1939) 353.—*Calymella vulcanica* PRESL, Abh. (K.) Böhm. Ges. Wiss. M.-N. Cl. 5 (1848) 338; CHING, Sunyatsenia 5 (1940) 287; NAKAI, Bull. Nat. Sc. Mus. Tokyo n. 29 (1950) 42.—*G. dicarpa* var. *vulcanica* CHRIST, Ann. Jard. Bot. Btzig 15 (1898) 75.—*G. squamosissima* COPEL. Philip. J. Sc. 75 (1941) 348, pl. 1.—*Calymella squamosissima* NAKAI, l.c.—Fig. 1d–e, i–n, 3.

Similar in habit to *G. microphylla*, differing as follows: *leaflets* commonly 4–5 mm apart; segments of *lamina* less than 1 mm long and wide; lower surface glaucous, deeply concave, with edges much reflexed and the surface adjacent to the costa also swollen; many small thin scales, with slender crisped marginal hairs, all along costules; *sporangia* 2 or 3, not in a depression in the *lamina*. At very high altitudes often only unbranched fronds, very densely scaly, are produced.

Type: Blume, Java (L).

Distr. *Malaysia*: Sumatra, Malay Peninsula (3 localities), W. Java, Borneo, Philippines (Mindanao, Mindoro), Celebes, and New Guinea.

Ecol. Abundant in open scrub (on both dry

stony and wet ground) on volcanic mountains throughout W. Java and Sumatra, 1800–3600 m, at these altitudes apparently less abundant on granite mountains in Borneo; densely scaly at highest elevations both in N. Sumatra and in New Guinea (*G. squamosissima* COPEL.).



Fig. 3. *Gleichenia vulcanica* BL. in the high mountains of Mt Goh Lembuh, Gajo Lands, N. Sumatra, sheltered in rock crevices, c. 3000 m (1937).

**4. *Gleichenia dicarpa* R.BR.** Prod. (1810) 161; C. CHR. Ark. Bot. 9<sup>11</sup> (1910) 33.—*Calymella dicarpa* PRESL, Abh. (K.) Böhm. Ges. Wiss. M.-N. Cl. 5 (1848) 338.—*Calymella circinnata* (non *G. circinnata* Sw.) CHING, Sunyatsenia 5 (1940) 288.—Fig. 1f–h.

Like *G. vulcanica*, but the *leaflets* not copiously scaly (costae almost or quite glabrous when mature), the aperture of the concave lower surface of each segment of the *lamina* reduced to much less than half of the area enclosed by the outline of the segment as seen from below, owing to much swelling of the costal tissue; *sporangia* 2, filling the aperture.

Type: Robert Brown, Tasmania (BM; dupl. at K).

Distr. Australia, New Caledonia, in *Malaysia*: New Guinea, Philippines (Mindanao).

Ecol. On Normanby and Rossel Islands, SE.

New Guinea, occurring at 750–850 m, in open forest or rocky places.

Note. Though typical specimens of *G. vulcanica* in Java differ markedly from typical specimens of *G. dicarpa* in Australia, some specimens on moun-

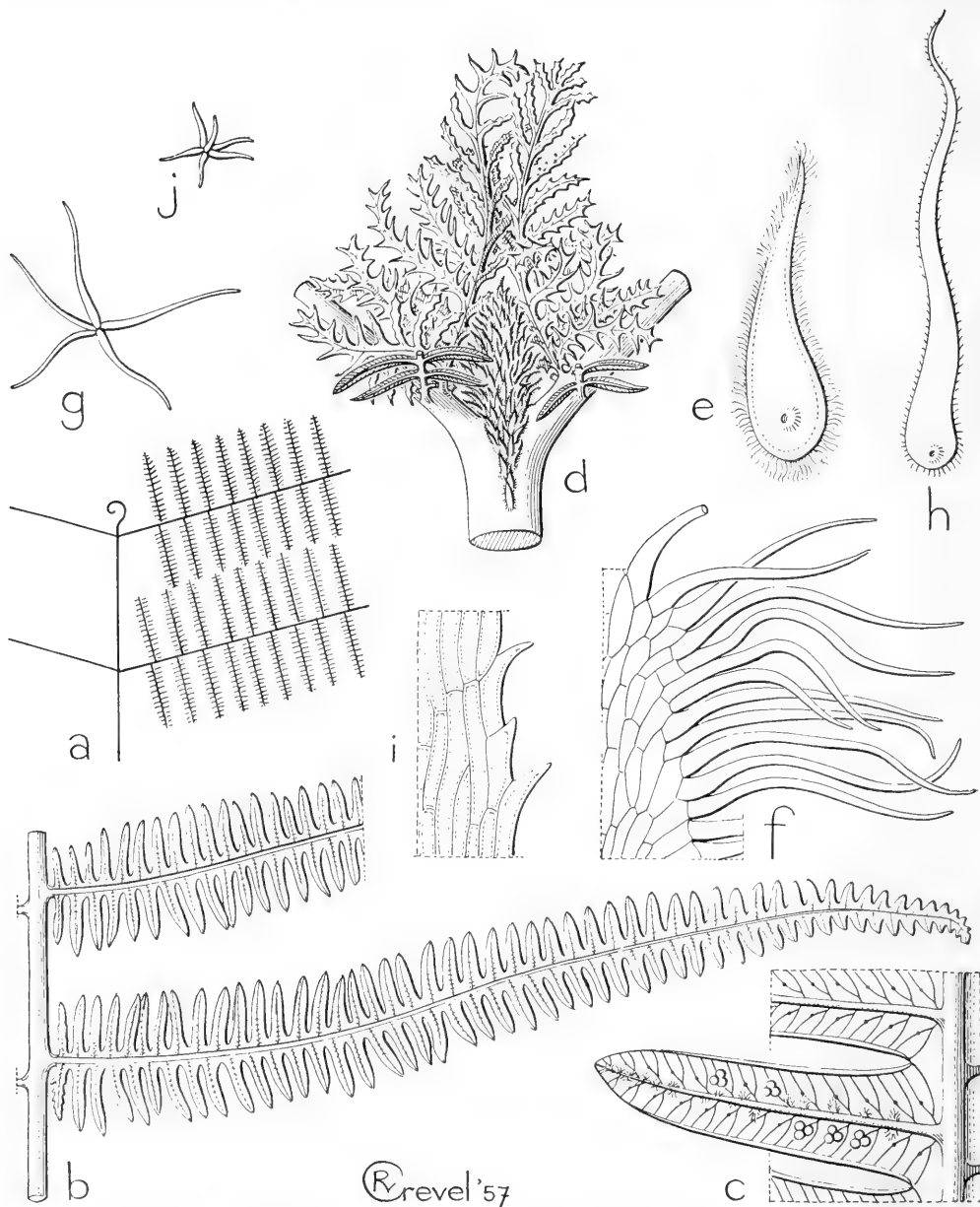


Fig. 4. a. Diagram of branching in *Gleichenia* subg. *Diplopterygium*. — *G. longissima* BL., b. Part of rachis-branch bearing two pinnules,  $\times \frac{2}{3}$ , c. segment of lamina, lower surface, showing veins and sori,  $\times 4$ , d. resting apex of main rachis and bases of branches, with stipular leaflets, nat. size. — Scales and hairs. — *G. longissima* BL., e. A single scale from apex of rachis,  $\times 8$ , f. edge of scale,  $\times 133$ , g. stellate hair,  $\times 33$ . — *G. conversa* v. A. v. R., h. A single scale,  $\times 8$ , i. edge of scale,  $\times 133$ , j. stellate hair,  $\times 33$ .

tains in Mindanao and New Guinea seem somewhat intermediate. Ecological distinctions between the two have not been studied.

CHRISTENSEN, in his notes on specimens in the herbarium of SWARTZ at Stockholm (*l.c.*) stated that the type specimen of *G. circinnata* was identical with *G. dicarpa* R. BR. With his original description SWARTZ gave no precise locality, but in his 'Synopsis Filicum' he stated that the species was from Botany Bay, near Sydney. The only specimen labelled *G. circinnata* in SWARTZ's herbarium from that locality is certainly not *G. dicarpa*, though it has only two sporangia on each lamina-segment; the segments are not pouch-

shaped in the manner of *G. dicarpa*. One can only conclude that CHRISTENSEN did not make a careful examination of the specimen. However, the Botany Bay specimen is not certainly the original on which the species *G. circinnata* was based (furthermore, the original description included the phrase *capsulis quaternis*, not true of the Botany Bay specimen). I therefore refrain from reverting to CHRISTENSEN's earlier identification of *G. microphylla* R. BR. with *G. circinnata* Sw.

After the publication of CHRISTENSEN's note, some botanists used the name *G. circinnata* to replace *G. dicarpa*, but it seems clear that this was an error, and I therefore restore R. BROWN's name.

## 2. Subgenus *Diplopterygium*

HOLTT. Reinwardtia 4 (1957) 261.—*Gleichenia* subg. *Mertensia* sect. *Diplopterygium* DIELS in E. & P. Pfl. Fam. 1, 4 (1900) 353.—*Gleichenia* subg. *Mertensia* § 1 HOOK. Sp. Fil. 1 (1844) 4.—*Gleichenia* subg. *Mertensia* sect. *Dicranopteris* v. A. v. R. Handb. (1909) 57, *p.p.*—*Dicranopteris* UND. Bull. Torr. Bot. Cl. 34 (1907) 249, *p.p.*—*Sticherus* § *Hicriopteris* C. CHR. in Verdoorn, Man. Pterid. (1939) 530.—*Hicriopteris* (non PRESL) CHING, Sunyatsenia 5 (1940) 277; COPEL. Gen. Fil. (1947) 28.—*Mesosorus* HASSK. Fil. Jav. 1 (1856) 2, *p.p.*—*Diplopterygium* NAKAI, Bull. Nat. Sc. Mus. Tokyo n. 29 (1950) 47.—Fig. 4-6.

Fronds of a young plant producing pairs of bipinnatifid branches, with periodic dormancy of the apex, from an early stage, the lateral branches of such fronds of immature plants small and sterile; periodic dormancy of the apex of the main rachis, and no other dormancy, occurring on *fronds* of mature plants; lowest leaflets on the branches often deltoid and bipinnatifid (or with deltoid-bipinnatifid lowest branchlets), forming stipule-like structures which protect the dormant apex of the main rachis; remaining leaflets very deeply pinnatifid, segments of the lamina oblong, each with a costa bearing on either side several once-forked veins. *Sori* on the acroscopic branches of the veins, several to each segment of the lamina.

Distr. More than 20 *sp.* in NE. India, Burma and Indo-China, China, Japan, Malaysia, Polynesia, Hawaii, and tropical America (1 *sp.*). This subgenus is far more diversified in Malaysia than elsewhere.

Ecol. All species occur on mountains, some descending to only 600 m. All may form dense thickets on edges of forest or other open places; fronds can climb to a height of 6-7 m, if trees suitable for support are present.

Note. Some fossils of Cretaceous age in West Greenland (lat. 70-71°N) have exactly the characters of this subgenus (habit of branching, venation, position of sori, nature of sporangia).

5. *Gleichenia laevisissima* CHRIST, Bull. Ac. Inst. Geogr. Bot. III, 11 (1902) 268; v. A. v. R. Handb. (1909) 795; Suppl. (1917) 82.—*Hicriopteris laevisissima* CHING, Sunyatsenia 5 (1940) 280.—*Diplopterygium laevisissimum* NAKAI, Bull. Nat. Sc. Mus. Tokyo n. 29 (1950) 52.

Scales on rachis-apex 10 mm long, nearly 3 mm wide, acuminate, entire; rest of *frond* quite glabrous except for very short simple hairs on lower surface of veins and lamina of young fronds and soral hairs. Primary rachis-branches to at least 70 cm long, lowest leaflets not stipule-like; leaflets at an angle of about 45° to rachis, largest 17-20 cm long, 2½-3 cm wide, costae 2½-3½ cm

apart; lamina lobed almost to the costa, costules at about 45° to the costa and 3½-4½ mm apart; segments of lamina 2-2½ mm wide above the base, narrowed gradually towards the apex; lower surface not glaucous, veins only slightly raised; upper surface not raised along margins of costae, veins raised only near their bases. *Sporangia* usually 4, pale, with very slender pale hairs.

Type: Bodinier 1295, Kouy-yang (P).

Distr. China (Kweichow, Chekiang, Yunnan, Fukien), Formosa, and Malaysia: Philippines (Luzon).

Ecol. In the mountains of Luzon, c. 2000 m.



Fig. 5. *Gleichenia longissima* BL. on edge of forest, Taiping Hills, Malaya, c. 800 m (HOLTUM, 1952).



**6. *Gleichenia paleacea* (COPEL.) HOLTT.** Reinwardtia 4 (1957) 265.—*Hicriopteris paleacea* COPEL. Philip. J. Sc. 81 (1952) 3.

Scales on main rachis-apex not seen; scales on primary branches and costae beneath very copious, light brown, larger ones 4–5 mm long and 1 mm wide, those on costae commonly 2 mm long and more than 0.5 mm wide, thin, fringe fine, close, concolorous; smaller scales narrower with long fine fringe and hair-tips; no persistent stellate hairs on veins except in sori. *Primary rachis-branch* more than 100 cm long (collector's note); costae  $2\frac{1}{2}$  cm apart, at right angles to rachis; largest pinnules 15–16 cm long,  $2\frac{1}{2}$ –3 cm wide, lobed almost to the costa, basal lobes slightly reduced and very close to the rachis; costules c. 4 mm apart, very slightly oblique; *lamina-segments* thin but firm, hardly narrowed above the base, edges slightly reflexed when dry so that sinuses between segments are 1–2 mm wide; lower surface glaucous, veins distinct and slightly raised; lamina on each side of the costa on upper surface raised as in *G. gigantea* WALL. and some long hairs persistent in the groove, veins slightly sunk in upper surface of lamina when dry. *Sori* commonly of 3 sporangia, with numerous pale hairs nearly 1 mm long.

Type: Elmer 9902 (Herb. Copel.; dupl. at BM, K, Bo, L, P).

Distr. *Malaysia*: Philippines (Negros: Cuernos Mts), once collected.

Note. This is near to *G. longissima* BL., but differs in persistent abundant scalliness. A collection of *G. longissima* from Canlaon Volcano, Negros (MERRILL 607) shows very scaly young parts of a frond, but the scales are much narrower and the old parts are glabrous.

**7. *Gleichenia volubilis* JUNGH.** Java 1 (1853) 592, 664; v. A. v. R. Handb. Suppl. (1917) 83, p.p.; BACKER & POSTH. Varenfl. Java (1939) 256.—*Mertensia arachnoides* HASSK. in Hook. J. Bot. Kew Misc. 7 (1855) 332.—*Mesosorus arachnoides* HASSK. Fil. Jav. 1 (1856) 6.—*G. arachnoides* METT. in Miq. Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 47; RACIB. Fl. Btzig 1 (1898) 11; v. A. v. R. Handb. (1909) 58 (*arachnoidea*); non *G. arachnoidea* CUNN. 1844.—*G. glauca* var. *arachnoides* C. CHR. Ind. Fil. (1905) 320.—*Hicriopteris volubilis* CHING, Sunyatsenia 5 (1940) 280.—*Diplopterygium volubile* NAKAI, Bull. Nat. Sc. Mus. Tokyo n. 29 (1950) 55.

var. *volubilis*.

Scales on main rachis-apex nearly black, to at least 6 mm long and  $1\frac{1}{2}$  mm wide, gradually narrowed towards apex, edges closely fringed with fine spreading pale hairs (or with a broad, thin translucent border bearing short hairs); similar but smaller scales on lower surfaces of branch-rachises, costae and costules (smallest scales not dark), these surfaces also densely covered with a persistent felt of pale stellate hairs each less than 0.5 mm diameter, old costae showing the raised points of attachment of former scales;

stellate hairs on costules and lower surface of veins rusty brown. *Primary rachis-branches* to at least 150 cm long and 30 cm wide; stipule-like leaflets present and deeply lobed; pinnules 12–16 cm long, 2–3 cm wide, costules  $3\frac{1}{2}$ –4 mm apart, at right angles to costae; *lamina-segments* firm, slightly narrowed above the base, their edges reflexed when dry, lower surface not (or very slightly?) glaucous, veins strongly raised; upper surface of rachis covered with stellate hairs as lower surface together with very narrow pale ciliate scales; smaller pale scales and hairs at first in groove of upper surface of costae (lamina slightly raised on each side of the groove); veins on upper surface paler than lamina and slightly raised in dried specimens (lamina between veins sometimes slightly raised but not swollen); *sporangia* surrounded by a group of crisped red-brown hairs.

Type: Junghuhn s.n., 1839, G. Gedeh (L).

Distr. *Malaysia*: Java, Sumatra, and Central Celebes (one collection).

Ecol. Forming dense thickets in open places on ridges, and on edges of forest, often very abundant, 1800–3000 m.

Note. The Celebes specimen has smaller pinnules than normal in Java (10–12 cm long,  $1\frac{1}{2}$  cm wide), with thinner lamina and veins hardly prominent beneath.

var. *peninsularis* HOLTT. Reinwardtia 4 (1957) 265.

Scales on lower surfaces of rachises and costae rusty brown like the stellate hairs, not black.

Type: F. M. S. Museum s.n., June 1917 (K).

Distr. *Malaysia*: Malay Peninsula (G. Bintang on Kedah-Perak boundary), once collected.

**8. *Gleichenia bullata* MOORE**, Ind. Fil. (1862) 374; C. CHR. Gard. Bull. S.S. 7 (1934) 212.—*G. volubilis* (non JUNGH.) v. A. v. R. Handb. Suppl. (1917) 83, p.p.—*Hicriopteris bullata* CHING, Sunyatsenia 5 (1940) 279.

Differs from *G. volubilis* JUNGH. as follows: scales on rachises, costae and costules much more abundant, those on costules often pale with a dark base; stipular leaflets lacking; *primary rachis-branches* shorter, pinnules commonly 1.3–1.5 cm apart, 6–9 cm long, 0.9–1.3 cm wide; veins on upper surface of *lamina* (when dry) much sunken, the surface between them swollen.

Type: Low, Mt Kinabalu, 7000 ft (K).

Distr. *Malaysia*: Borneo (Sarawak: Mts Dulit and Tibang; N. Borneo: Mt Kinabalu), New Guinea (Mt Dayman).

Ecol. Forming thickets like *G. volubilis*, 1700–3000 m.

Note. The bullate character of the upper surface of the lamina, and the scalliness, distinguish this from dwarfed specimens of *G. volubilis* which may have pinnules no larger than those normal in *G. bullata*.

**9. *Gleichenia longissima* BL.** En. Pl. Jav. (1828) 250; RACIB. Fl. Btzig 1 (1898) 10; BACKER &

POSTH. Varenfl. Java (1939) 256; HOLTT. Rev. Fl. Mal. 2 (1955) 67.—*G. excelsa* J. Sm. ex Hook. Sp. Fil. 1 (1844) 5, t. 4B.—*G. glauca* v. A. v. R. Handb. (1908) 58 et al. p.p.—*Hicriopteris longissima* CHING, Sunyatsenia 5 (1940) 280.—*Diplopterygium longissimum* NAKAI, Bull. Nat. Sc. Mus. Tokyo n. 29 (1950) 53.—Fig. 4b–g, 5.

*Scales* on resting apex of rachis as in *G. volubilis* JUNGH.; young expanding parts of fronds covered with loose indumentum of narrow rust-coloured scales and lax stellate hairs, a few such scales and hairs sometimes persistent on lower surface of costae and costules, mature rachises quite smooth and glabrous. *Primary rachis-branches* to about 200 cm long and 40 cm wide; largest pinnales 15–22 cm long, 2½–3½ cm wide, costae 2.8–3½ cm apart; lamina thin, lobed almost to costa, costules 4–5 mm apart, slightly oblique to costa; *segments of lamina* slightly narrowed above the base, edges slightly reflexed when dry; lower surface glaucous, veins slender and slightly raised; upper surface of rachis and costae glabrous, lamina slightly raised on each side of costae; veins on upper surface slightly raised near base, rarely also distally, very slender; *sori* usually of 3 sporangia, surrounded by crisped brown hairs.

Type: Blume, Java (L; dupl. at K, P).

Distr. Southern China to Indo-China through Malaysia to Melanesia (Fiji, Tahiti), in *Malaysia*: not collected in the Lesser Sunda Islands E of Flores, Celebes, the Moluccas, and New Guinea.

Ecol. Forming thickets in clearings and on edges of forest, more or less persisting in open secondary forest; 750–1800 m. RACIBORSKI states that this species may climb very high on trees.

Note. This is the most widely distributed species in the subgenus. In Java and Sumatra it is replaced at higher altitudes by *G. volubilis*; a comparison of the two species near the transition zone needs to be made.

**10. *Gleichenia clemensiae* (COPEL.) HOLTT. comb. nov.**—*Hicriopteris clemensiae* COPEL. Un. Cal. Publ. Bot. 18 (1942) 217.—*G. papuana* HOLTT. Reinwardtia 4 (1957) 266.

*var. clemensiae.*

*Scales* on resting apex of main rachis dark brown, shining, 4 mm long, more than 1 mm wide, edges bearing spreading hairs to 0.5 mm long; lower surface of rachises and costae bearing numerous persistent scales like those on the resting apex but smaller, dark and shining with pale edges and fringe, those on the costae commonly 1½ mm long and ½ mm wide, old costae minutely warty from the raised bases of former scales; scales on lower surface of costules abundant, very small, laxly fringed; no hairs on veins, apart from sori; upper surface of rachis rather persistently covered with very narrow scales and long lax hairs, upper surface of costae hairy near the base only. *Rachis-branches* 120 cm long; pinnales spreading at right angles, 2½ cm apart, largest 12 cm long, 2 cm wide; costules 2½–3 mm apart; lamina thin, veins slightly prominent on lower surface, not on

upper; *sori* commonly of 3 sporangia, with crisped paraphyses.

Type: Clemens 41227, Morobe, Matap, 5000–6000 ft (H. Copel.).

Distr. *Malaysia*: SE. New Guinea (Morobe, and Milne Bay Distr.: Mt Dayman).

Ecol. Scrambling to 2–3 m, forming dense tangles on edges of mossy forest, 1600–2250 m.

*var. membranacea* (HOLTT.) comb. nov.—*G. papuana* var. *membranacea* HOLTT. Reinwardtia 4 (1957) 266.

*Scales* on rachis-apex pale and very thin near the edges which are very shortly fringed; scales on rachises and costae more abundant, dark at the base only.

Type: Brass 24763 (BM).

Distr. *Malaysia*: New Guinea (Goodenough I.).

Ecol. Plentiful in openings in forest, 1600 m.

**11. *Gleichenia angustiloba* HOLTT. Reinwardtia 4 (1957) 263.**

Rhizome 7 mm diam., young parts covered with shining dark brown scales 5–7 by 1½ mm, old parts warty from bases of former scales; stipes 6–7 mm diam., the base at first scaly like the rhizome and then warty, upper part covered with small scales like those of the rachises, later asperulous. *Primary rachis-branches* 100 cm long or more; stipular leaflets broadly deltoid, to 4 cm long, pinnatifid, lowest lobes deeply and narrowly lobed again; scales on apex of main rachis dark brown, shining, narrow, 3–4 mm long, the edges bearing concolorous oblique rigid setae; rachises and costae, and lower surfaces of costules more or less persistently covered with smaller scales of various sizes and red-brown stellate hairs. Pinnales to 15 cm long and 3–3½ cm wide, 2–3½ cm apart, the distal ones distinctly deflexed, the lower ones at right angles to rachis; all *segments of the lamina* c. 2½ mm wide, separated by wide sinuses, many of the lower segments being constricted at the base and joined laterally by a very narrow wing along the costa (wing about 0.2 mm wide); lowest segments forming distinct separate leaflets; costules 4 mm apart; veins prominent on both surfaces; *sori* of 4 sporangia with long red-brown crisped hairs, no other hairs on the veins of mature fronds.

Type: Brass 4960, Mt Tafa (BM, dupl. at K, Bo, US).

Distr. *Malaysia*: E. New Guinea (Mt Tafa, and on Asaro-Mairi Divide, Goroka Subdistr.).

Ecol. Altitude 2400 m; "Common in native rest clearings in ridge-crest forest; conspicuous, rambling amongst forest fringe bushes and small trees; fronds 4–5 m with 6–8 or more pairs of large spreading pinnae" (BRASS).

**12. *Gleichenia elmeri* COPEL. in Elmer, Leaf. Philip. Bot. 3 (1910) 799.**—*Diplopterygium elmeri* NAKAI, Bull. Nat. Sc. Mus. Tokyo n. 29 (1950) 49.

Scales on rachis-apex not seen; scales on costae sparse; scales on costules at first abundant,



longest 1–1½ mm long, narrow, rusty brown with well-spaced rigid spreading marginal hairs; very small scales and stellate hairs present on veins and with sporangia, hair-branches stiff, c. 0.2 mm long; dark brown short clavate hairs abundant on costules and less so on sides of costae. Pinnae 150 cm long (*vide* COPELAND); largest pinnules 25 cm long, 3½–4 cm wide, 4½–5 cm apart; costules 5½–7 mm apart, at right angles to costa; several segments of lamina constricted at base, widely separated and joined by a wing ½ mm wide along the costa; lower surface pale green, veins slightly raised; upper surface of lamina along sides of costae wrinkled when dry, probably somewhat raised in living fronds; veins not raised on upper surface except near base; sporangia commonly 3–5, less often 6 or 7, not always completely covering lower surface (as reported in original description); numerous pale hairs, longer than sporangia, attached to the receptacle.

Type: Elmer 11423 (H. Copel.; dupl. at K, US, F, L, P).

Distr. *Malaysia*: Philippines (Mindanao: Mt Apo), once collected.

**13. *Gleichenia deflexa* HOLTT.** Reinwardtia 4 (1957) *addendum* p. 280.

*Scales* on apex of main rachis light brown with darker obliquely setose edges; branch rachises and lower parts of costae at first covered on both surfaces with a close felt of small setose scales and stellate hairs and also with numerous narrow scales (those on rachis 5 mm long, 0.2 mm wide), setae of scales and hairs of upper surface all rigid and rather dark, of smaller scales and hairs on lower surface pale and lax; lower surface of costules scaly and hairy near their bases like the costae; lower surface of veins bearing persistent scattered stellate hairs with slender pale rays. *Rachis-branches* 120 cm or more long, fertile ones to 35 cm wide, sterile sometimes only 18 cm wide, all pinnules distinctly deflexed, making angles of about 75° with the rachis; costae on large fertile rachis-branches 4½ cm apart, on smaller sterile branches 2½–3½ cm apart; fertile pinnules 16–20 cm long, widest part 3½–3.8 cm wide, costules 4–5 mm apart; lamina thin, veins raised near their bases on both surfaces when dry; 20 or more pairs of segments on each larger pinnule constricted at the base, connected by a very narrow wing along the costa, c. 3½ mm wide above the base, lowest segment sometimes quite free and shortly stalked; sori of 3–5 sporangia; stipular leaflets to 4 cm long, bipinnatifid, segments c. 1 mm wide, acuminate.

Type: Brass 27171, Ferguson Isl. (L).

Distr. *Malaysia*: SE. New Guinea (Normanby and Fergusson Islands).

Ecol. Scrambling to 7 m high in rather open forest, 800–850 m.

**14. *Gleichenia sordida* COPEL.** in Elmer, Leaf. Philip. Bot. 3 (1910) 798.—*G. novoguineensis* BRAUSE, Bot. Jahrb. 56 (1920) 210.—*Hicriopteris novoguineensis* COPEL. Philip. J. Sc. 75 (1941) 358.

—*Hicriopteris astrotricha* COPEL. *l.c.*—*Diplopterygium novoguineense* NAKAI, Bull. Nat. Sc. Mus. Tokyo n. 29 (1950) 54.—*G. sumatrana* HOLTT. Reinwardtia 4 (1957) 264.

*Scales* on dormant apex of rachis 8–10 mm long, 0.5 mm wide, light brown with dark edges bearing oblique setae; rachises and costae more or less persistently covered with a felt of stellate hairs (all dark brown or some rusty brown) and some narrow scales to 4 mm long; lower surfaces of costules and veins more or less persistently covered with stellate hairs. *Rachis-branches* 120–200 cm long, costae 2½–4½ cm apart; largest pinnules 15–20 cm long, 2½–3 cm wide, slightly deflexed or not; costules 3½–4½ mm apart; 2–8 basal segments of lamina on each pinnule constricted at the base and connected by a very narrow wing along the costa, rest separated by narrow sinuses; lamina rather thin, not glaucous beneath; veins raised on lower surface, sometimes not on upper surface; sori of 3–5 sporangia; stipular leaflets broadly deltoid, 2½–4½ cm long, their lobes c. 1 mm wide.

Type: Elmer 11423a, Mt Apo, Mindanao (H. Copel.; dupl. at US, BM).

Distr. *Malaysia*: Sumatra, Malaya, Celebes, Moluccas (Halmahera, Batjan, Morotai), Philippines (Mindanao), New Guinea, and Solomons.

Ecol. High-climbing in open forest and on forest-edge, apparently not forming thickets, 1000–2000 m.

**15. *Gleichenia norrisii* METT.** in Kuhn, Linnaea 36 (1869) 165; v. A. v. R. Handb. (1908) 58; C. CHR. Gard. Bull. S.S. 7 (1934) 212, *incl. var. floccigera* C. CHR.; HOLTT. Rev. Fl. Mal. 2 (1955) 67.—*Hicriopteris norrisii* CHING, Sunyatsenia 5 (1940) 280.—*Diplopterygium norrisii* NAKAI, Bull. Nat. Sc. Mus. Tokyo n. 29 (1950) 54.—Fig. 6.

*Scales* on apex of main rachis 2–3 mm long, narrow, medium brown, edges bearing short oblique concolorous setae; costae and costules when mature quite glabrous or bearing a few scales near the base; young rachises, costae and costules bearing scattered very narrow brown scales, small setose scales and stellate hairs with rusty brown rays; stellate hairs at first present on veins but not persistent. *Rachis-branches* 100 cm or more long; largest pinnules to 20 cm long and 3 cm wide, the costae 4–5 cm apart, distinctly deflexed, distal pinnules more acutely deflexed than basal ones; lobes of lowest pinnules usually only slightly enlarged and not stipuliform, but stipule-like leaflets, with broad blunt lobes, sometimes produced; costules 4½–5½ mm apart; lamina light green, drying light olive green without reddish tinge, thin, lower surface more or less glaucous in young plants, often not appreciably so in older ones; segments of lamina only slightly narrowed above the base, separated by sinuses not over 1 mm wide, apices broadly rounded, lowest segments much reduced but not separated from the rest; veins slender, distinctly raised on lower surface, slightly on upper surface; sori



Fig. 6. *Gleichenia norrisii* METT. on edge of forest, Penang, c. 650 m; one pair of rachis-branches showing widely spaced and deflexed pinnules (HOLTUM, 1926).

commonly of 3-5 sporangia, with *paraphyses* consisting of small scales bearing long, pale, marginal hairs.

Type: Norris, Malay Peninsula (B?; dupl. at K, BM, P).

Distr. *Malaysia*: Malay Peninsula, Sumatra (Bencoolen), and N. Borneo.

Ecol. In clearings and on edge of forest, 650-1250 m. On Penang Hill this species is abundant at 650-750 m, below the lower limit of altitude of *G. longissima*; above 750 m the latter, which forms denser thickets because of its closer pinnules, is the common species.

Note. CHRISTENSEN's *var. floccigera* was based on immature fronds which had not lost their indumentum. The development of stipule-like leaflets varies, but they never have the narrow caudate lobes found in most other species.

**16. *Gleichenia matthewii* HOLTT.** Reinwardtia 4 (1957) 265.

*Scales* of main rachis-apex hardly  $\frac{1}{2}$  mm wide, edges with their setae shining dark brown, middle part paler; costae bearing a few scales near the base, the frond otherwise glabrous. *Rachis-branches* 70 cm or more long, strongly flexuous above the basal part; all pinnules deflexed, the upper ones at an angle to  $45^\circ$  so that each is in line with the portion of the rachis beyond it, the uppermost grading into the spreading lobes of the terminal lamina; largest pinnules 12 cm long and  $2\frac{1}{2}$  cm wide, the costae 4 cm apart; costules  $4\frac{1}{2}$  mm apart; *lamina* firm, glaucous beneath, lobed to  $1-1\frac{1}{2}$  mm from the costa, segments oblong, contiguous, almost truncate at the apex and often slightly retuse; no *sori* seen; *stipular leaflets* deltoid, 2 cm long, narrowly lobed.

Type: Petersen s.n., 31 Jan. 1912, G. Singalang (K).

Distr. *Malaysia*: Central Sumatra (Mt Singalang), twice collected, altitude 1800 m.

**17. *Gleichenia brevipinnula* HOLTT.** Reinwardtia 4 (1957) 264.

*Scales* on apex of rachis *c.* 5 mm long, hardly  $\frac{1}{2}$  mm wide, brown, with almost black shining edges bearing oblique setae; rachises rather persistently covered with very dark rigid stellate hairs with a few narrow scales; scattered similar hairs on costae and costules beneath, and scattered somewhat paler stellate hairs on lower surface of veins. Main *rachis* 5 mm diameter; branches 70 cm long; costae *c.* 2 cm apart, pinnules to 10 cm long and 2 cm wide, not or slightly deflexed; costules  $3-3\frac{1}{2}$  mm apart; *lamina* cut down to 1 mm from the costa, very firm, sinuses very narrow, edges of segments slightly toothed near apices at the ends of the veins, lower surface strongly glaucous; veins raised on both surfaces; *stipular leaflets*  $3\frac{1}{2}$  cm long, broadly deltoid, all lobes with very narrow caudate tips, lower lobes deeply and very obliquely lobed again; segments of sub-basal pinnules often with caudate tips like the stipular leaflets; *sori* of 3 or 4 sporangia.

Type: Bell 2042, Pueh Range, Sarawak (BM).

Distr. *Malaysia*: Borneo (Sarawak & N. Borneo).

Ecol. On ridges and summits of mountains, in dwarf forest or scrub, 1250-2500 m. Fronds are reported up to  $2\frac{1}{2}$  m long.

**18. *Gleichenia blotiana* C. CHR.** Bull. Mus. Hist. Nat. Paris II, 6 (1934) 103.—*Hicriopteris blotiana* CHING, Sunyatsenia 5 (1940) 279.—*Diplopterygium blotianum* NAKAI, Bull. Nat. Sc. Mus. Tokyo n. 29 (1950) 49.

*Scales* on dormant apex of rachis nearly black, edges bearing oblique black setae; scales on growing main rachis usually with a paler median band; rachis-branches when young bearing many dark stellate hairs with rigid rays (so close that hairs touch each other but do not completely obscure surface of rachis) and also very narrow ciliate scales 2 mm long and some long lax multicellular hairs; a similar indumentum on upper surface of costae at first, later deciduous; indumentum on lower surface of costae and costules mostly of dark rigid stellate hairs, with a few scales at bases of costae; dark stellate hairs scattered abundantly on veins and lamina beneath, persistent. *Main rachis-branches* *c.* 150 cm long, the lowest pinnules stipule-like,  $3\frac{1}{2}$  cm long, deltoid, with very narrow deeply pinnatifid basal lobes; pinnules commonly 20 cm long, 3-4 cm wide, the base of the costa distinctly deflexed as in *G. norrisii*; costae 4-5 cm apart, costules *c.* 5 mm apart; segments of lamina  $3\frac{1}{2}$ -4 mm wide, rather thin, their apices broadly rounded and sometimes retuse; veins distinctly raised on upper surface and slightly so below; *sporangia* 3-4 in each sorus.

Type: Pételot 3900, near Chapa, Indo-China (BM; dupl. at P).

Distr. Indo-China and S. China, in *Malaysia*: Malay Peninsula, once collected.

Ecol. In the Malay Peninsula on edge of forest in a thicket with *G. longissima*, at 1500 m.

**19. *Gleichenia conversa* v. A. v. R.** Bull. Jard. Bot. Botz II, n. 20 (1915) 17; Handb. Suppl. (1917) 81; BACKER & POSTH. Varenfl. Java (1939) 255.—*Diplopterygium conversum* NAKAI, Bull. Nat. Sc. Mus. Tokyo n. 29 (1950) 49.—**Fig. 4h-j.**

Differs from *G. norrisii* as follows: *scales* on rachis-apex brown with almost black edges; some rather light brown stellate hairs often persistent on costules and sides of costae; largest pinnules to 25 cm long and 4 cm wide; distal pinnules not appreciably deflexed; *segments of lamina* separated by sinuses about 2 mm wide; lamina and rachises drying rather red-brown, lamina usually thicker than in *G. norrisii*; veins usually not at all raised on upper surface (slightly so in specimens with thin lamina); *stipular leaflets* well developed, the lobes narrow.

Type: Hasskarl, Kandang Badak, G. Gedeh (Bo; dupl. at L).

Distr. *South Malaysia*: Java and Lesser Sunda Islands (Flores).

Ecol. In open places in forest and on forest-edges, 900-2400 m.

3. Subgenus *Mertensia*

HOOK. Sp. Fil. 1 (1844) 6, *pro* § 2; HOLTT. Reinwardtia 4 (1957) 266.—*Mertensia* WILLD. Kongl. Vet. Ak. Nya Handl. 25 (1804) 163, *p.p.*, *non* ROTH 1797.—*Gleichenia* subg. *Mertensia* sect. *Holopterygium* DIELS in E. & P. Pfl. Fam. 1, 4 (1900) 353.—*Dicranopteris* (*non* BERNH.) UND. Bull. Torr. Bot. Cl. 34 (1907) 249, *p.p.*—*Gleichenia* subg. *Mertensia* sect. *Dicranopteris* v. A. v. R. Handb. (1908) 56, *p.p.*—*Sticherus* PRESL, Tent. Pterid. (1836) 51; CHING, Sunyatsenia 5 (1940) 281; COPEL. Gen. Fil. (1947) 27; NAKAI, Bull. Nat. Sc. Mus. Tokyo n. 29 (1950) 7.—*Sticherus* § *Eu-Sticherus* C. CHR. in Verdoorn, Man. Pterid. (1938) 530.—*Mesosorus* HASSK. Fil. Jav. 1 (1856) 2, *p.p.*—Fig. 7–10.

Primary rachis-branches each ending in a dormant apex which lies in the angle between a pair of secondary branches; secondary branches behaving similarly, the process usually repeated to produce pseudo-dichotomous branching of several orders; ultimate branches simply deeply pinnatifid, the *venation* of segments of the lamina and sori as in subg. *Diplopterygium*; penultimate branches (often also

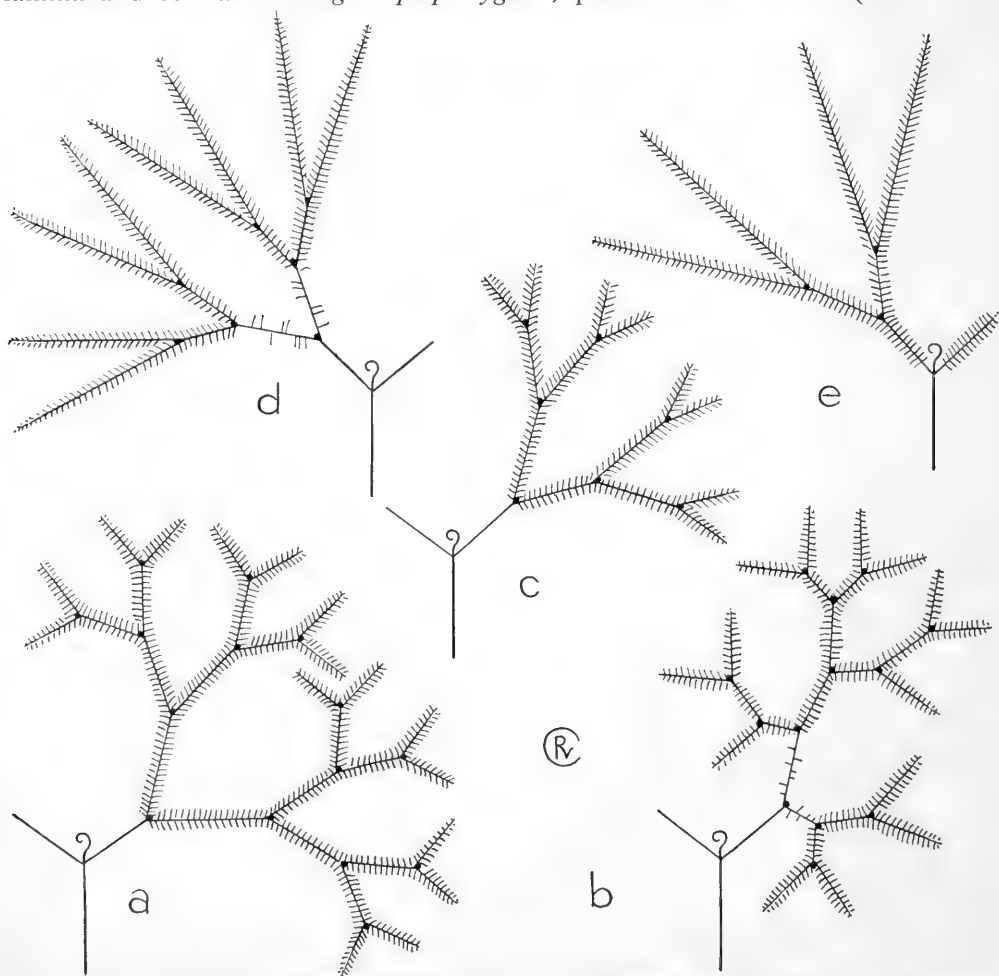


Fig. 7. Diagrams showing branching habit of species of *Gleichenia* subg. *Mertensia*. a. *G. truncata* (WILLD.) SPR., b. *G. milnei* BAK., c. *G. hispida* METT., d. *G. hirta* BL., e. *G. vestita* BL.

branches of lower orders) more or less completely provided with a deeply pinnatifid lamina like that of the ultimate branches.

**Notes.** This subgenus includes far more species than any other major division of the family, in all continents, and its distribution is mainly south of the equator. Most of the species are rather small in size, as compared with representatives of *subg. Diplopterygium*, and could not compete as thicket-forming ferns either with the latter or with *Dicranopteris*. The only Malaysian species which can so compete is *G. truncata*, and it is also the only species of *subg. Mertensia* which occurs at sea-level in our region. The others are mountain plants occurring in scrub and dwarf forest of high ridges or in open grassy or rocky places, which are comparable with the habitats of related species in south temperate regions.

As in other divisions of the family, the characters and distribution of scales and hairs are important diagnostically in this subgenus. The number of times the lateral branch-systems are forked (the number of orders of forking) is probably important, but shows considerable variation within a species according to the age of the plant and to environmental conditions, and these cannot be fully judged from dried specimens. A more important kind of character is the relative length of branches of the first and ultimate orders. But in some species one frond will have branch-systems forked to 2 orders with long ultimate branches, other fronds (even part of the same frond) may be forked to 3 orders with much shorter ultimate branches. The glaucous character of the lower surface of the lamina may be significant, but is easily destroyed by heat in drying. In all these characters, and in all species, more field study is needed to establish distinctions between species more clearly.

Judging from anatomical characters, CHRYSLER (Am. J. Bot. 31, 1944, 483-491) has argued that *subg.*

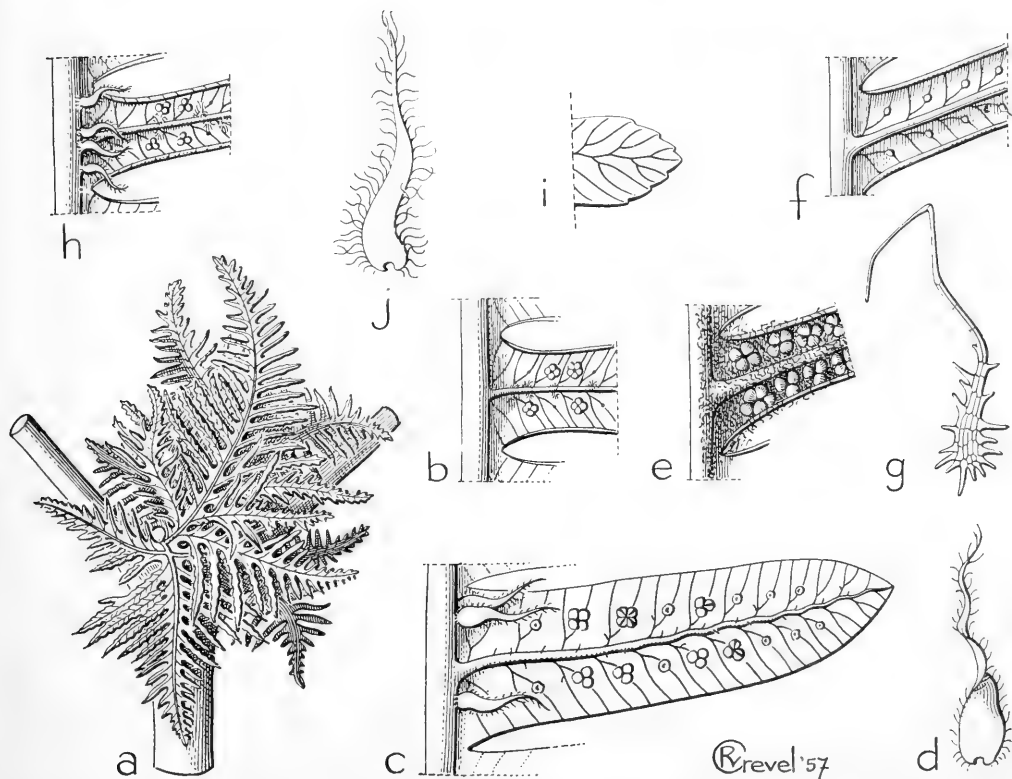


Fig. 8. *Gleichenia truncata* (WILLD.) SPR. *a.* Stipular leaflets at main branching, nat. size, *b.* lower surface of part of frond,  $\times 4$ . — *G. vestita* BL., *c.* Lower surface of a large segment of lamina,  $\times 4$ , *d.* a single scale from costa,  $\times 8$ . — *G. hispida* METT., *e.* Lower surface of part of frond, showing sori and hair-pointed scales,  $\times 8$ , *f.* same with scales and sporangia removed, *g.* a single scale from costa,  $\times 22$ . — *G. hirta* BL. *h.* Lower surface of part of frond,  $\times 4$ , *i.* tip of a segment of the lamina, showing toothed edge, *j.* a scale from the costa,  $\times 20$ .

*Mertensia* is the most primitive division of the genus. But from the point of view of sporangia and sori it is exactly in equality with *subg. Diplopterygium*, and in leaf-form it is clearly more highly organized (in having a branching-pattern dependent on a series of permanently dormant apices). It seems to me significant that among fossils none are clearly referable to this subgenus, whereas there are abundant fossils having a close resemblance to *subg. Diplopterygium*. An apparent exception is *Gleichenites gracilis* ZIGNO. But the branching-pattern of this fossil is very irregular and there is no clear evidence of pseudo-dichotomy; I think that its resemblance to *subg. Mertensia* is superficial.

**20. *Gleichenia reflexipinnula* C. CHR.** Brittonia 2 (1937) 27.—*Sticherus reflexipinnula* COPEL. Philip. J. Sc. 75 (1941) 355.

Rhizome 5 mm diameter, covered when young with dark brown shining acuminate scales hardly 1 mm wide at the base, when old closely warty; stipe 30 cm or more long, scaly and then warty like the rhizome near the base; main *rachis* bearing 2 or more pairs of primary branches, with deeply pinnatifid stipular leaflets 2–4 cm long at bases of branches; primary branches once or twice forked, leafy down to the junction with the main *rachis*, not proliferous beyond the first fork; angle of ultimate forks rather less than a right angle; ultimate branches to c. 20 cm long and 3½–4 cm wide (shorter if primary branch is twice forked), penultimate branches 3½–9 cm long; *scales* on resting apex of main *rachis* 3½ mm long, less than 1 mm wide, acuminate but not hair-pointed, rather thin, medium brown with short sparse fringe of paler hairs; *scales* on main *rachis* persistent, abundant, thin, pale and long-fringed; *scales* on lower surface of costae abundant, largest 2 mm long, ½ mm wide, thin, pale, long-fringed; *scales* on costules similar and smaller, abundant, ranging down to stellate hairs; no stellate hairs on veins; *lamina* lobed almost to the costa, middle and upper segments slightly deflexed, lower ones much deflexed, costules 3½ mm apart; segments gradually narrowed to apex (which is sometimes retuse), coriaceous, edges strongly revolute when dry, veins hardly raised on either surface; *sporangia* usually 4, sori close together.

Type: Brass 4847, Mt Tafa (BM; dupl. at Bo, US).

Distr. *Malaysia*: E. New Guinea (Mt Tafa, Mt Dayman).

Ecol. Forest-edge, subscandent to 2 m (Mt Dayman), plentiful in summit clearing (Mt Tafa), 2230–2700 m.

**21. *Gleichenia venosa* (COPEL.) HOLTT., comb. nov.**—*Sticherus venosus* COPEL. Philip. J. Sc. 75 (1941) 356, pl. 5.

Habit of *G. truncata* and of similar size (*rachis*-branches of second order sometimes only partly leafy); segments of *lamina* thicker, with edges sometimes much reflexed when dried, the veins on the lower surface strongly raised; *scales* of apex of main *rachis* similar to those of *G. truncata*; *scales* on costae abundant and persistent, dark rusty-brown, to 1½ mm long and more than ½ mm wide, fringed; *scales* on costules similar but smaller, very abundant, spreading and closely overlapping so as completely to cover lower surface of *lamina*; smaller *scales* also present

throughout on *rachises*, persistent as a continuous rusty covering at and just below the forks.

Type: Brass 12348, Idenburg River (H. Copel.; dupl. at Bo, BM, L).

Distr. *Malaysia*: New Guinea.

Ecol. Thickets in open places, scrambling to 2–3 m, 1600–2700 m.

**22. *Gleichenia truncata* (WILLD.) SPR.** Syst. Veg. ed. 16, 4 (1827) 25; HOLTT. Reinwardtia 4 (1957) 271.—See for further synonyms under the varieties. —Fig. 7a, 8a–b, 9.

#### KEY TO THE VARIETIES

1. Additional stipular leaflets present about 1 cm below main and first lateral forks of *rachis*, as well as just above forks. 2. *var. bracteata*
1. Such additional stipular leaflets lacking.
2. Costae persistently densely scaly on the upper surface. 4. *var. involuta*
2. Costae at most sparingly and not persistently scaly on the upper surface.
3. Main *rachis*-branches several times forked. Scales on costae beneath very small or narrow and acuminate.
4. Scales on costae sparse and very small. 1. *var. truncata*
4. Scales on costae 1½–2 mm long, 0.3–0.6 mm wide, acuminate. 5. *var. celebica*
3. Main *rachis*-branches 2 or 3 times forked. Scales on costae beneath rather abundant, 1–1½ mm long, 0.7–1 mm wide.
3. *var. plumaeformis*

1. *var. truncata*.—*Mertensia truncata* WILLD. Kongl. Vet. Ak. Nya Handl. 25 (1804) 169, t. V, f. A.—*Mertensia laevigata* WILLD. Sp. Pl. 5 (1810) 75.—*Sticherus laevigatus* PRESL, Tent. Pterid. (1836) 52.—*G. laevigata* HOOK. Sp. Fil. 1 (1844) 10; RACIB. Fl. Bitz 1 (1898) 11; v. A. v. R. Handb. (1908) 59; BACKER & POSTH. Varenfl. Java (1939) 255; HOLTT. Rev. Fl. Mal. 2 (1955) 71.—*Sticherus truncatus* NAKAI, Bull. Nat. Sc. Mus. Tokyo n. 29 (1950) 20.—*Sticherus myriapoda* NAKAI, l.c. 12, f. 1.

Main *rachis* 8 mm or more diameter near the base, often high-climbing with many pairs of branches; primary *rachis*-branches several times almost equally forked, the angle of forking about a right angle, of ultimate forks sometimes more than 90°; basal segment of primary *rachis*-branch leafless (apart from stipular leaflets), branches of second and later orders usually all leafy, length of each branch from one fork to the next commonly 10–15(–20) cm; stipular leaflets usually present at base of primary branch and at its first fork,



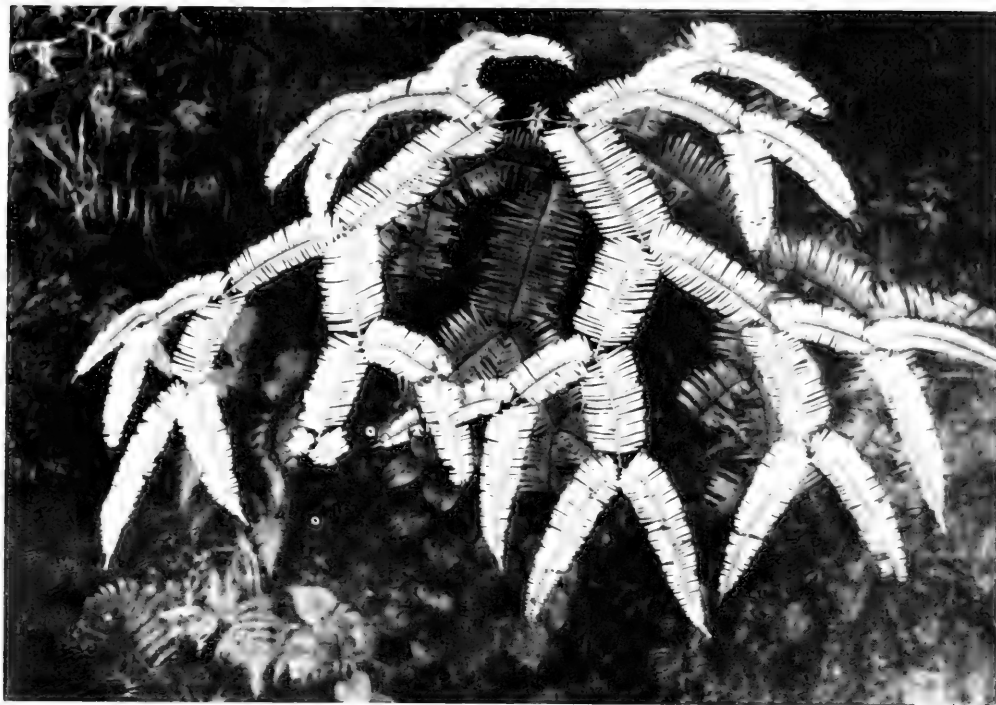


Fig. 9. *Gleichenia truncata* (WILLD.) SPR. on Taiping Hills, Malaya, by roadside, c. 1200 m (HOLTUM, 1952).

deltoid and deeply lobed (basal lobes again lobed), at base of primary rachis-branch to 3 cm long, at next fork  $1\frac{1}{2}$  cm long; lamina cut almost to the costa into lobes at right angles to the costa; lobes rather irregular in length even on same branch, longest on lowest branches, commonly  $2\text{--}3\frac{1}{2}$  cm long (to 5 cm) and about  $2\frac{1}{2}$  mm wide (to 3 mm), costules 3–4 mm apart; lower surface not glaucous, veins dark when dry, slightly raised; veins on upper surface not raised when dry, concolorous; *sori* of 3–5 sporangia, surrounded by pale hairs. *Scales* on smaller dormant apices mostly very small, often not more than 1 mm long, rusty brown, of varying shape, fringed; on larger apices also some very narrow scales; scales on costae very small, long-fringed, at first rather abundant; very short simple hairs, often shrivelled and black when old, present on lower surface of costules, veins and lamina.

Type: Herb. Willd. (B).

Distr. Throughout *Malaysia*, apparently most abundant in the west.

Ecol. On edges of forest, often climbing to a considerable height, 0–1600 m, growing with varieties of *Dicranopteris linearis*, also in thickets at higher altitudes.

Note. The original specimen of *Mertensia truncata* WILLD. had incompletely expanded lamina-lobes, which thus appeared to be truncate.

*Sticherus myriapoda* NAKAI was described from

a plant in the Riouw Archipelago differing only from typical *var. truncata* in having a twining main rachis. Such a condition has also been observed in one plant in Johore, but is not general in this variety. Experimental culture is desirable to decide whether the twining condition is genetically controlled. The Johore plant had rachises twining both to the left and to right, and the length of rachis making one complete turn round the support was about 20 cm. NAKAI described a closer spiral.

2. *var. bracteata* (BL. ex HOOK. & BAKER) HOLTUM. Reinwardtia 4 (1957) 271.—*G. bracteata* BL. ex HOOK. & BAKER, Syn. Fil. (1865) 14 (as synonym but with descr.)—*G. laevigata* *var. bracteata* v. A. v. R. Handb. Suppl. (1917) 85.

Lamina-segments commonly less than 2 mm wide, 10–18 mm long; additional *stipular leaflets* present about 1 cm below main and first lateral forks of rachis, on the outside.

Type: Blume, Java (L; dupl. at K).

Distr. *Malaysia*: Java, Flores, S. Celebes.

Ecol. On edges of forest, apparently abundant at 1000–1600 m; extremes of altitude recorded 600 and 2000 m.

3. *var. plumaeformis* (PRESL) HOLTUM. Reinwardtia 4 (1957) 272.—*Mertensia plumaeformis* PRESL, Abh. (K.) Böhm. Ges. Wiss. M.-N. Cl. V,

5 (1848) 338; Epim. Bot. (1851) 24, t. 15.—*Sticherus plumeaformis* NAKAI, Bull. Nat. Soc. Mus. Tokyo n. 29 (1950) 25.

*Primary rachis-branches* once or twice forked, 3–6 cm to first fork (this part almost or quite leafless), ultimate branches up to 25–35 cm long; costae usually bearing rather numerous, thin, broad, almost entire *scales* 1–1½ mm long, 0.7–1 mm wide, on lower surface.

Type: Cuming 377, Malacca (PRC; dupl. at K, BM, P, L, F).

Distr. *Malaysia*: Sumatra, Malay Peninsula, Borneo (?).

Ecol. In open places on mountains, 1200–1800 m. As seen by me in W. Sumatra this variety does not form long climbing fronds.

**4. var. involuta** HOLTT. Reinwardtia 4 (1957) 272.

*Primary rachis-branches* 3 times forked; ultimate branches sometimes much longer than lower ones; ultimate forks forming an angle of rather less than 90°; upper surfaces of costae densely scaly, scales persistent, 1 mm long, pale-fringed; lower surfaces of costae bearing *scales* ½ mm long; edges of dried lamina-lobes much revolute.

Type: J. Winkler; Rosenst. Fil. Sum. Exsic. 182 (L; dupl. at BM, P).

Distr. *Malaysia*: N. Sumatra (Karo Plateau).

**5. var. celebica** HOLTT., var. nov.

*Primary rachis-branches* 3 times equally forked, ultimate and penultimate branches leafy, angle of ultimate forks less than a right angle, segments of lamina c. 2 cm long; *scales* on lower surface of costae copious, acuminate, fringed, c. 1½–2 mm long, 0.3–0.6 mm wide.

Distr. *Malaysia*: Central Celebes, altitude 2600–3000 m (once collected).

**23. *Gleichenia milnei*** BAKER, Syn. Fil. (1874) 449; Hook. Ic. Pl. t. 1602; HOLTT. Reinwardtia 4 (1957) 270.—*G. kajewskii* COPEL. Philip. J. Sc. 60 (1936) 102, pl. 6.—*Sticherus milnei* CHING, Sunyatsenia 5 (1940) 284.—*Sticherus kajewskii* COPEL. Gen. Fil. (1947) 27.—Fig. 7b.

General aspect of *frond* as in *G. truncata* (in its wide forkings and narrow lamina-segments at right angles to the costa), but at each fork (apart from forks of main rachis) one branch larger than the other, larger branches alternately to left and right and successive larger branches almost in line with each other; ultimate branches, and branches of 2–3 lower orders leafy; leafy branches in general 2½–3½ cm wide (lower ones to 4½ cm), lamina-segments 2–3 mm wide, costules 3–5 mm apart; *scales* as in *G. truncata*; additional *stipular leaflets* often present outside the lower forks, as in *G. truncata* var. *bracteata* but nearer the forks.

Type: Milne 341, New Hebrides (K).

Distr. *Malaysia*: Celebes, ? Philippines (? Luzon), Moluccas, New Guinea, Admiralty Islands, Solomon Islands, New Hebrides.

Ecol. Altitude 100–1400 m.

**24. *Gleichenia oceanica*** KUHN, Verh. K. K. Zool.-Bot. Ges. Wien 19 (1869) 583; non CHRIST, Ann. Jard. Bot. Btztg 15 (1898) 76; v. A. v. R. Handb. (1908) 60; Suppl. (1917) 85, 497; COPEL. Univ. Cal. Publ. Bot. 12 (1931) 388.—*Sticherus oceanicus* ST JOHN, Occ. Pap. Bish. Mus. 17 (1942) 81.

Habit and scaliness of *G. truncata*, but the forkings of the rachis-branches much less than a right angle (ultimate forks often less than 45°), the lamina glaucous beneath, its segments distinctly oblique and commonly less than 2 cm long (often not more than 1½ cm); *primary rachis-branches* of large fronds 5 times forked, with deltoid stipular leaflets at their base, of smaller fronds sometimes only 3 times forked and lacking stipular leaflets.

Type: Herus 66, Aneityum, New Hebrides (B).

Distr. Melanesia (New Hebrides, Fiji, Samoa), may occur in East Malaysia.

Note. The SARASIN specimens from Celebes referred to this species by CHRIST (*l.c.*) are *G. hispida* and *G. hirta* var. *paleacea*; I have not seen the WARBURG specimen.

**25. *Gleichenia erecta*** C. CHR. Brittonia 2 (1937) 269; HOLTT. Reinwardtia 4 (1957) 268.—*Sticherus erectus* COPEL. Philip. J. Sc. 75 (1941) 353.—*Sticherus habbemensis* COPEL. *l.c.* 355, pl. 3.

Rhizome 2½–4 mm diameter, young parts covered with thin brown ciliate scales to 3 mm long and 1 mm wide, old parts closely warty; stipe at first scaly, then warty, near the base, like the rhizome, rest smooth, 12–40 cm long; *frond* bearing one or more pairs of primary branches which are simple or once or twice forked, sometimes proliferous beyond the first pair of secondary branches; if twice forked, the first-order branch 2–3 cm long, bearing a stipular lobed leaflet 15 mm long and sometimes 1 or 2 other lamina-segments but not fully leafy, the second-order branch 3–6 cm long, fully leafy; angle of ultimate forks less than 45°; ultimate branches 12–30 cm long, largest *lamina-segments* commonly 15–23 mm long, sometimes to 40 mm, rather coriaceous, entire, edges much reflexed when dry, abruptly narrowed just above the base, the rest 2–2½ mm wide when flattened, tapering to apex, lower surface glaucous; veins not raised on either surface; costules 3–4 mm apart (lowest ones on large fronds to 5 mm apart), basal part at 60–70° to the costa, distal part often falcate when dry; *scales* on resting apices of main rachis like those on base of stipe but more finely fringed; some persistent scales on lower surface of costae, 1½ mm long, ½ mm wide, shortly hair-pointed, edges fringed at least towards the apex (these scales sometimes very pale with a darker base); scales on costules very small and long-fringed; paleray-stellate hairs on veins, their red-brown bases sometimes persistent; *sori* of 3–4 sporangia.

Type: Brass 4591, Murray Pass, Wharton Range, Papua (BM; dupl. at K, Bo, US).

Distr. *Malaysia*: New Guinea.

Ecol. In open places, in peaty grassland, and on wet clay-soil of land-slips, 1000–3225 m.



**26. *Gleichenia pulchra* (COPEL.) HOLTT.** Reinwardtia 4 (1957) 271.—*Sticherus pulcher* COPEL. Philip. J. Sc. 75 (1941) 355, pl. 4.

Main *rachis* slender, bearing several pairs of branches, each primary branch bearing up to at least 3 pairs of secondary branches, each secondary branch simple or once forked; only ultimate branches leafy, except sometimes where a secondary branch is forked, in which case the penultimate branch may bear a few lamina-lobes; ultimate branches to 20 cm long and  $2\frac{1}{2}$  cm wide (to 3 cm wide if a simple secondary branch), *lamina* lobed almost to the costa, segments very slightly oblique, 3 mm wide above the base, costules 4 mm apart; veins slightly raised on lower surface, on upper surface only at the base of each vein; lower surface glaucous when living (not clearly so on dried specimens available); *scales* on main dormant apices small, on lower surface of costae  $\frac{1}{2}$ –1 mm long, firm, dark brown with a pale fringe; scales on lower surface of costules abundant, small, long-fringed; many small rusty-brown stellate hairs on lower surface of veins and on lamina.

Type: Brass 12351, Idenburg River (H. Copel.; dupl. at BM, L).

Distr. *Malaysia*: New Guinea (NW. part, once collected, SE. part, doubtful).

Ecol. Scrambling in mossy forest, 1650 m.

**27. *Gleichenia pseudoscandens* v. A. v. R. Nova Guinea 14 (1924) 24.**—*Sticherus pseudoscandens* COPEL. Philip. J. Sc. 75 (1941) 356.

Fronds to 4 m long, with several pairs of primary branches; primary branch-systems usually with 3 orders of forking, the *primary branch* sometimes proliferous beyond its first pairs of branches, only the ultimate branches leafy; ultimate branches to 40 cm long, lower ones 10–20 cm long; costules  $5\frac{1}{2}$ –6 mm apart, at right angles to the costa or nearly so; segments of lamina 17–25 mm long, 3 mm wide above the base, *lamina* firm, drying dark, veins not raised on either surface; *scales* on resting apex of main rachis 4–5 mm long, rigid, dark, very narrow, with short oblique marginal setae; scales on lower surface of costae dark and small, almost entire, mostly deciduous leaving the surface warty; very short hairs copious on lower surface of lamina and on costules; some hairs with the sporangia.

Type: Lam 1935, Doorman summit (U; dupl. at L, Bo, BM).

Distr. *Malaysia*: NW. New Guinea, once collected.

Ecol. Altitude 2480 m.

**28. *Gleichenia alstonii* HOLTT.** Reinwardtia 4 (1957) 267.

Main *rachis* 4 mm diameter; primary branch-systems usually with forking of two orders, only the ultimate branches leafy; primary branches rarely proliferous beyond the first fork; branches of first order 4–5 cm long, of second order 6–7 cm long; ultimate branches 30–35 cm long,  $3\frac{1}{2}$  cm wide, the basal 10–15 mm sometimes

bare of lamina; costules 4 mm apart, slightly oblique; segments of *lamina* c. 17 mm long, 3 mm wide above the base, thin, apices entire or nearly so, veins slightly prominent on both surfaces; *sori* of 3–4 sporangia. *Scales* on dormant apex of rachis 4 mm long, 0.7 mm wide, narrowly acuminate, brown, with short spreading pale marginal hairs near base, dark oblique sparse setae towards apex; scales on lower surface of costae scattered, dark,  $1\frac{1}{2}$  mm long, 0.2 mm wide, edges with sparse oblique dark hairs; scales on lower surface of costules pale, very narrow; scattered pale lax stellate hairs on lower surface of veins.

Type: Alston 14981, Lae Pandom (BM).

Distr. *Malaysia*: N. Sumatra (Tapanuli), once collected.



Fig. 10. *Gleichenia vestita* BL. on ridge with ericoid ridge forest from Poka Pindjang to Rante Mario in the Latimodjong Range, Central Celebes, c. 3000 m (1937).

**29. *Gleichenia vestita* BL.** En. Pl. Jav. (1828) 249; RACIB. Fl. Btzg 1 (1898) 11; v. A. v. R. Handb. (1908) 61; Suppl. (1917) 86; BACKER & POSTH. Varenfl. Java (1939) 255.—*Sticherus vestitus* CHING, Sunyatsenia 5 (1940) 285.—Fig. 7e, 8c–d, 10.

*Rachis* of a well-grown frond bearing several

pairs of primary branches, usually without *stipular leaflets* at their base; primary branch-systems usually forked to 2 orders (rarely 3), primary branch not proliferous beyond its first fork; all branches leafy, down to junction with main rachis; angle of forks about 45°; ultimate branches 15–25 cm long, lower ones 5–7 cm long; *lamina* cut down to within 1 mm of costa, segments distinctly oblique, thin but very rigid, 8–12 mm long, not narrowed immediately above the base but tapering very gradually, then abruptly to broadly pointed or rounded entire apex, edges not usually much reflexed, lower surface glaucous; costules 4–5 mm apart; veins slightly raised on both surfaces; *sori* of 3–5 sporangia, without evident paraphyses. *Scales* on dormant apex of main rachis firm, rusty to rather dark brown, 4–5 mm long, more than 1 mm wide, gradually narrowed to hair point, edges rather sparsely obliquely ciliate towards apex; scales on lower surface of costae abundant and persistent, spreading, rusty brown, 0.6–1.2 mm wide, 2–3 mm long, ciliate towards hair-pointed apex; smaller scales few, stellate hairs quite lacking; very short reddish simple hairs frequent on costules and veins beneath.

Type: Blume, Java (L; dupl. at K).

Distr. *Malaysia*: Sumatra, Java, S. Celebes.

Ecol. In open alpine forest and scrub, 2300–2800 m.

Note. At high elevations and in exposed places, fronds may be smaller than above described, with branches of first and second order only 2–3 cm long.

**30. *Gleichenia bolanica*** ROSENST. in Fedde, Rep. 12 (1913) 162; v. A. v. R. Handb. Suppl. (1917) 86.—*G. monticola* RIDL. Trans. Linn. Soc. Bot. 9 (1916) 252.—*G. subulata* v. A. v. R. Nova Guinea 14 (1924) 23.—*Sticherus bolanicus* COPEL. Philip. J. Sc. 75 (1941) 352.—*Sticherus monticola* NAKAI, Bull. Nat. Sc. Mus. Tokyo n. 29 (1950) 23.

Lateral branch-systems of well-grown fronds with forks to 4th order; primary branches not normally proliferous beyond first fork nor bearing stipular leaflets at their base; ultimate branches 7–20 cm long, 6–10 mm wide, lower branches 1–2 cm long; usually only ultimate and penultimate branches leafy, but lower ones sometimes partly leafy; *lamina* cut almost down to the costa, segments apparently triangular because of their much-reflexed edges, 3 mm wide at the base, rather thick and very rigid when dry, lower surface glaucous with slightly raised veins; costules slightly oblique; *sori* often very crowded, of 3–6 sporangia. *Scales* on dormant apex of main rachis rigid, dark and shining, 3–4 mm long, to 0.7 mm wide, apex not hair-pointed, marginal hairs short, oblique, rigid; scales on lower surface of costae abundant, to 2 mm long, not hair-pointed, base 0.5–0.7 mm wide, brown at base and pale distally, edges bearing short hairs which are sometimes very rigid and dark brown; small similar scales or stellate hairs on costules and veins.

Type: Keysser B. 14, Mt Bolan, New Guinea (B).

Distr. *Malaysia*: New Guinea.

Ecol. In open scrub or rocky places, fronds to 2 m or more long, 2800–3950 m.

**31. *Gleichenia hispida*** METT. ex KUHN, Verh. K. K. Zool.-Bot. Ges. Wien 25 (1875) 600; RACIB. Fl. Btzig 1 (1898) 12; v. A. v. R. Handb. (1908) 61; BACKER & POSTH. Varenfl. Java (1939) 255; HOLTT. Reinwardtia 40 (1957) 270.—*G. koordersii* CHRIST. Ann. Jard. Bot. Btzig 15 (1898) 76, pl. 13, f. 1.—*Sticherus caudatus* COPEL. Philip. J. Sc. 75 (1941) 354, pl. 2.—*Sticherus hispidus* COPEL. Gen. Fil. (1947) 27.—*Sticherus pinnatus* COPEL. Philip. J. Sc. 83 (1954) 98, pl. 3.—**Fig. 7c, 8e–g.**

Well-grown fronds with several pairs of primary branches which are not proliferous beyond their first fork and have no *stipular leaflets*; lateral branch-systems with forks to 2nd or 3rd order; branches of first order leafless or only partly leafy, rest fully leafy; first order branches 2½–6 cm long, second order branches 5–12 cm long; from second-order fork to end of ultimate branches (whether 2 or 3 forks present) 20–30 cm, the third fork (if present) about the middle of this length; *lamina* cut almost down to the costa, the segments slightly oblique, coriaceous, stiff and rigid when dry with much-recurved edges, longest segments on lower branches to 3½ cm long, on ultimate branches sometimes only 1 cm long, effective width when dry 1½–2½ mm, costules 3–4 mm apart; lower surface of *lamina* more or less glaucous, veins dark and slightly prominent, not raised on upper surface; *sori* of 3 or 4 sporangia with rather long crisped rusty hairs. *Scales* on dormant apex of main rachis rusty brown, 5–7 mm long, 0.5 mm wide, narrowed above the base and for the most part very narrow, hair-pointed; scales on lower surface of costae only a few cells wide at the base, the hair-point forming at least half of the length, hair-points crisped and entangled with those of other scales; scales on costules similar and smaller, grading to stellate hairs on veins and edges.

Type: Jagor 558, G. Galungung (B; not seen). Syntype: De Vries, Ternate (dupl. at U).

Distr. *Malaysia*: Sumatra, Java, Bali, N. Celebes, Ternate, and Philippines (Negros, Luzon).

Ecol. In thickets in open places, 1000–2200 m.

Note. Isolated plants in exposed places may have fertile fronds much smaller and less branched than those described; *Sticherus pinnatus* COPEL. appears to represent a condition of this species with unbranched fertile fronds.

**32. *Gleichenia brassii*** C. CHR. Brittonia 2 (1937) 271.—*Sticherus brassii* NAKAI, Bull. Nat. Sc. Mus. Tokyo n. 29 (1950) 15.

Rhizome 6 mm diameter, strongly warty from bases of old scales, young parts scaly, scales 5 mm long, 1 mm wide, ciliate; stipes to 100 cm long, persistently scaly throughout but only warty near the base, scales of all sizes with rather copious pale fringe, the longest ones hair-pointed; main rachis to about 200 cm long, bearing several pairs

of primary branches which lack stipular leaflets; lateral branch-systems with forks of 2 orders, ultimate and penultimate branches fully leafy, ultimate forks less than  $90^\circ$ ; first and second order branches 12–15 cm long, ultimate branches 30–40 cm long and  $4\frac{1}{2}$  cm wide; costules about 5 mm apart, at right angles to costae; segments of lamina 3 mm wide above the base, firm, edges more or less revolute when dry, lower surface not glaucous when dry; veins slightly prominent on lower surface, not on upper surface except their bases; sori of 3–4 sporangia without evident paraphyses. Scales on dormant apex of main rachis like those on rhizome but thinner, edge shortly ciliate, apex a short hair; scales on lower surface of costae spreading,  $1\frac{1}{2}$ –2 mm long, 0.5 mm wide, thin, brown, darker at the base, shortly hair-pointed, closely fringed with spreading pale hairs; scales on lower surface of costules abundant,  $\frac{1}{2}$ –1 mm long, rusty brown with long pale fringe; upper surface of costae raised and terete, bearing persistent small pale long-fringed scales, rest of upper surface glabrous; lower surface of veins bearing many very short simple hairs.

Type: Brass 4922, Mt Tafa (BM; dupl. at Bo).

Distr. *Malaysia*: New Guinea (Mts Arfak and Tafa).

Ecol. Scrambling in open places in forest, 1550–2400 m.

**33. *Gleichenia loheri*** CHRIST, Bull. Herb. Boiss. II, 6 (1906) 1009; v. A. v. R. Handb. (1908) 796; HOLTT. Reinwardtia 4 (1957) 272.—*Sticherus loheri* COPEL. Gen. Fil. (1947) 27.—*Sticherus perpaleaceus* COPEL. Philip. J. Sc. 81 (1952) 3.

var. *loheri*.

Lateral branch-systems with forks of 1, 2 or 3 orders, ultimate and penultimate branches fully leafy, angle of ultimate fork much less than a right angle; with forks of 1 or 2 orders, penultimate branches 5–7 cm long, ultimate branches 17–23 cm long; with forks of 3 orders, ultimate and penultimate branches together 17–20 cm long; ultimate branches  $1\frac{1}{2}$ –2.2 cm wide, costules  $3\frac{1}{2}$  mm apart, at right angles to costa or very slightly oblique, lamina cut almost down to the costa, segments not abruptly narrowed above the base, edges when dry somewhat reflexed, apex rounded and entire, texture firm but not coriaceous, veins distinctly raised on lower surface, slightly so above, lower surface not glaucous when dry; sori of 3–4 sporangia. Scales on apex of main rachis 5 mm long, 1 mm wide, thin, medium rusty brown, hair-pointed, edges with oblique slender hairs; scales on lower surface of costae copious and spreading, the largest 2 mm long, 0.8 mm wide, shortly hair-pointed; scales on costules very small, long-fringed, pale, mixed with long-armed stellate hairs; upper surface of costae raised and terete, more or less persistently covered with small pale long-fringed interlacing scales; very short simple hairs abundant on lower surface of veins and occasionally also on lamina.

Type: Loher s.n., 7 Feb. 1906, Mt Banaho (P).

Distr. *Malaysia*: Philippines (Luzon).

var. *major* HOLTT. Reinwardtia 4 (1957) 272.

Larger than typical form of species; ultimate branches 20–30 cm long,  $2\frac{1}{2}$ – $3\frac{1}{2}$  cm wide, costules 3–4 mm apart; 3-lobed stipular leaflets 15 mm long sometimes present.

Type: Bunnemeijer 11965, Celebes (Bo; dupl. at L, K).

Distr. *Malaysia*: S. Celebes, N. Borneo, and Philippines (Negros).

Ecol. Altitude 2000–2500 m.

**34. *Gleichenia flabellata*** R. Br. Prod. (1810) 161; Hook. Sp. Fil. 1 (1844) 6; DOMIN, Bibl. Bot. 85 (1915) 204; v. A. v. R. Handb. (1908) 60; K. SCH. & LAUT. Fl. Schutzgeb. (1901) 144.—*Sticherus flabellatus* H. St. JOHN, Occ. Pap. Bish. Mus. 17 (1942) 81.

Stipe to 60 cm long, scaly at the base; main rachis bearing 2 or more pairs of branches; lateral branch-systems compact, forked to 3 orders at short intervals (lower branches commonly 1 cm long, penultimate 2–3 cm long), ultimate and penultimate branches leafy, angle of forks less than  $45^\circ$ ; ultimate branches 12–15 cm long, 2–3(–4) cm wide; costules 4 mm apart, at an angle of  $45^\circ$  to the costa; lamina cut almost to the costa, segments  $2\frac{1}{2}$  mm wide above the base, edges toothed almost to the base, apex broadly pointed, veins very oblique and raised on both surfaces, lower surface not glaucous. Scales on apex of main rachis 4 mm long, shining medium brown, acuminate, fringe copious, long, lax; scales on lower surface of costae few and persistent only near base, narrow, hair-pointed and long-fringed; smaller scales or long-armed pale stellate hairs occasional on costules near base of branch, surfaces otherwise glabrous.

Type: Robert Brown, Port Jackson, N. S. Wales (BM; dupl. at K).

Distr. E. & SE. Australia, New Caledonia, New Zealand, in *Malaysia*: E. New Guinea (SCHUMANN & LAUTERBACH l.c.).

**35. *Gleichenia hirta*** BL. En. Pl. Jav. (1828) 250; v. A. v. R. Handb. (1908) 60; Suppl. (1917) 85; HOLTT. Reinwardtia 4 (1957) 268.

—See for further synonyms under the varieties.—Fig. 7d, 8h–j.

Main rachis bearing several pairs of branches, not high-climbing; lateral branch-systems forked in 2–4 orders (rarely 5), the first-order branches in most varieties not normally proliferous beyond their first fork; ultimate branches always much longer than those of lower order, angle of ultimate forks less than  $45^\circ$ ; lamina thin, cut almost down to the costa into thin oblique segments, edges distinctly toothed towards apices of segments, lower surface more or less glaucous (glaucous character destroyed by heat in drying). Scales on apex of main rachis to 5 mm long, less than 1 mm wide, fringed with short hairs; scales on costae abundant or not, spreading,  $1\frac{1}{2}$ –2 mm long, less than  $\frac{1}{2}$  mm wide, thin and rather pale, not

conspicuously hair-pointed, edges fringed with slender hairs; smaller scales and stellate hairs also present on costae, costules and veins, or quite

lacking; *sori* with raised receptacle, conspicuous paraphyses present or not.

## KEY TO THE VARIETIES

1. Lower surface of costae of fully expanded ultimate branches scaly near the base only or more generally, the scales all about equal in size with rather rigid fringing hairs; no scales on costules nor on veins except when young.
2. Scales 3–4 cells wide at the base. Ultimate branches to 40 cm long and 3½ cm wide.
  2. *var. amoena*
2. Scales wider. Ultimate branches rarely over 25 by 2½ cm.
  3. Costules 4–4½ mm apart . . . . . 3. *var. paleacea*
  3. Costules 3½–4 mm apart . . . . . 4. *var. candida*
1. Lower surface of costae persistently scaly almost throughout, the scales of various sizes, often with lax fringe; smaller scales also persistent on costules and sometimes scales or hairs on veins.
4. Segments of the lamina not abruptly narrowed above the base, separated by narrow sinuses.
5. Scales on costules abundantly long-fringed.
6. Ultimate branches of well-grown fronds 2–3 cm wide; primary rachis-branches not always proliferous beyond first fork . . . . . 1. *var. hirta*
6. Ultimate branches 1½–2½ cm wide; primary rachis-branches always proliferous beyond first fork.
  5. *var. amboinensis*
5. Scales on costules with very few long marginal hairs . . . . . 6. *var. virescens*
4. Segments of lamina c. 2 mm wide except at the very base, separated by sinuses 1–1½ mm wide.
  7. *var. lanuginosa*

1. *var. hirta*.—*Dicranopteris dolosa* COPEL. in Perk. Frag. Fl. Philip. (1905) 193, t. 4 f.c.—*G. dolosa* C. CHR. Ind. Fil. (1906) 664; v. A. v. R. Handb. (1908) 62; Suppl. (1917) 85.—*Sticherus hirtus* CHING, Sunyatsenia 5 (1940) 203 (*err. hirsutus*).

Lateral branch-systems forked in 3 or 4 orders; ultimate branches 15–22 cm long, 2–2½ cm wide (rarely to 3 cm); penultimate branches fully leafy and often wider than ultimate ones; costules 3 mm apart; scales on lower surface of costae copious, persistent, of many sizes together, very long-fringed; pale stellate hairs present on veins.

Type: Reinwardt, Tidore (L; dupl. at BM).

Distr. *Malaysia*: Moluccas and Philippines (Luzon, Mindoro, Mindanao), 1200–1800 m.

2. *var. amoena* (v. A. v. R.) HOLTT. Reinwardtia 4 (1957) 269.—*G. amoena* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 23 (1916) 12; Handb. Suppl. (1917) 497.—*Sticherus amoenus* NAKAI, Bull. Nat. Sc. Mus. Tokyo n. 29 (1950) 13.—*G. peninsularis* COPEL. Un. Cal. Publ. Bot. 12 (1931) 387.—*Sticherus peninsularis* CHING, Sunyatsenia 5 (1940) 284.—*G. hirta*; HOLTT. Rev. Fl. Mal. 2 (1955) 71.

Lateral branch-systems forked in 1–3 orders; penultimate branches fully or partly leafy, branches of lower order not leafy; ultimate branches 25–40 cm long, 2½–3½ cm wide; costules 4–4½ mm apart; lamina-segments 3–3½ mm wide above the base, strongly glaucous beneath; scales on lower surface of costae narrow (fringe of hairs longer than width of scale), very sparse and near base of costae only, mature fronds otherwise glabrous (stellate hairs on veins when young).

Type: Teysmann 16628, Lingga (Bo; dupl. at P).

Distr. *Malaysia*: Sumatra, Lingga Archipelago, Malay Peninsula.

Ecol. Altitude 700–1600 m; scrambling or trailing in lightly shaded places or edge of forest, not forming dense thickets; fronds usually not over 200 cm long.

3. *var. paleacea* (BAK.) C. CHR. Gard. Bull. S. S. 7 (1934) 212; HOLTT. Reinwardtia 4 (1957) 269.—*G. vestita* var. *paleacea* BAK. J. Bot. 17 (1879) 38.—*G. hallieri* CHRIST, Ann. Jard. Bot. Btzig 20 (1905) 138; v. A. v. R. Handb. (1908) 61.—*G. barbula* C. CHR. Dansk Bot. Ark. 9, 3 (1937) 67.—*Sticherus hallieri* NAKAI, Bull. Nat. Sc. Mus. Tokyo n. 29 (1950) 18.—*Sticherus barbula* NAKAI, l.c. 13.

Lateral branch-systems usually forked in 2 or 3 orders (to 5 orders in type specimen of *G. barbula*); if in 2 orders penultimate branches incompletely leafy and ultimate branches to 30 cm long, otherwise ultimate branches 15–24 cm long and 2–2½ cm wide; costules 4–4½ mm apart; scales on mature fronds confined to costae and all alike (not mixed with smaller ones) with rather stiff fringing hairs as long as width of scale.

Type: Burbidge, N. Borneo (K).

Distr. *Malaysia*: Borneo, Lesser Sunda Islands (Bali), Celebes (Menado), 1100–3000 m.

Ecol. On Mt Kinabalu on open places in ridge forest.

4. *var. candida* (ROSENST.) HOLTT. Reinwardtia 4 (1957) 269.—*G. candida* ROSENST. in Fedde, Rep. 5 (1908) 33; v. A. v. R. Handb. (1908) 796.—*Sticherus hirtus* var. *candidus* NAKAI, Bull. Nat. Sc. Mus. Tokyo n. 29 (1950) 19.

Similar to *var. paleacea*, but costules 3½–4 mm apart, lamina of firmer texture.

Type: Werner 72, Mt Gelu (B; dupl. at BM, US, L).

Distr. *East Malaysia*: New Guinea, Admiralty Islands, Solomon Islands.

Ecol. On edges of forest and in light shade, sometimes forming dense thickets to 3 m high, 700–2150 m.

**5. var. amboinensis** (v. A. v. R.) HOLTT. Reinwardtia 4 (1957) 269.—*G. amboinensis* v. A. v. R. Bull. Dép. Agr. Ind. Néerl. n. 18 (1908) 3; Handb. (1908) 62; Suppl. (1917) 85 (as a synonym).

Like *var. hirta* in scaliness; ultimate branches  $1\frac{1}{2}$ – $2\frac{1}{2}$  cm wide; *primary rachis-branch* always proliferous beyond first fork and bearing 2 or more pairs of secondary branches.

Type: Teysmann, Amboyna (Bo; dupl. at L).

Distr. *Malaysia*: S. Central Celebes, Moluccas (Ambon, Buru, Waigeo Isl.).

Ecol. Climbing to 4 m in open places in mountain forest.

**6. var. virescens** (HIERON.) HOLTT. Reinwardtia 4 (1957) 270.—*G. dolosa* var. *virescens* HIERON. ex BRAUSE, Bot. Jahrb. 56 (1920) 209.—*Sticherus hirtus* var. *virescens* NAKAI, Bull. Nat. Sc. Mus. Tokyo n. 29 (1950) 19.

Similar to *var. hirta*, but scales on costules with very few long marginal hairs.

Type: Ledermann 9935 (B).

Distr. *Malaysia*: E. New Guinea.

Note. Collector of type specimen stated that lower surface of lamina was white (*i.e.* glaucous) when fresh.

**7. var. lanuginosa** (v. A. v. R.) *comb. nov.*—*G. ornamentalis* ROSENST. Nova Guinea 8 (1912) 715; v. A. v. R. Handb. Suppl. (1917) 85.—*G. ornamentalis* var. *lanuginosa* v. A. v. R. Nova Guinea 14 (1924) 23.—*Sticherus lamianus* COPEL. Philip. J. Sc. 75 (1941) 356, pl. 6.—*G. hirta* var. *ornamentalis* (ROSENST.) HOLTT. Reinwardtia 4 (1957) 269.

Lateral *branch-systems* commonly forked to 4 orders; costae persistently and densely scaly, scales as in *var. hirta*; costules 3–4 mm apart, *segments of lamina* 2 mm wide, thus separated by rather wide sinuses.

Type: Lam 1945, Doormantop, 3480 m (U; dupl. at Bo, US, L).

Distr. *Malaysia*: New Guinea.

Ecol. Altitude 800–2500 m; specimens from the higher altitudes are the most densely scaly.

## 2. DICRANOPTERIS

BERNHARDI in Schrad. Neu. J. Bot. 1, 2 (1806) 38; UNDERW. Bull. Torr. Bot. Cl. 34 (1907) 244, *p.p.*; CHING, Sunyatsenia 5 (1940) 272; COPEL. Gen. Fil. (1947) 28; NAKAI, Bull. Nat. Sc. Mus. Tokyo n. 29 (1950) 56; HOLTT. Reinwardtia 4 (1957) 273.—*Mertensia* WILLD. Kongl. Vet. Ak. Nya Handl. 25 (1804) 163, *p.p.*; PRESL, Tent. Pterid. (1836) 50, *p.p.*; *non* ROTH, 1797 (*Borag.*).—*Gleichenia* subg. *Mertensia*, § III and § IV, HOOK. Sp. Fil. 1 (1844) 11, 12.—*Hicriopteris* PRESL, Epim. Bot. (1851) 26, *non* CHING, *nec* COPEL.—*Gleichenia* subg. *Mertensia* sect. *Heteropterygium* DIELS in E. & P. Pfl. Fam. 1, 4 (1900) 355.—*Gleichenia* subg. *Mertensia* sect. *Dicranopteris* v. A. v. R. Handb. (1908) 56, *p.p.*—*Mesosorus* HASSK. Fil. Jav. 1 (1856) 2, *p.p.*—**Fig. 11–16.**

Indumentum on rhizome, dormant apices, and on other parts of fronds consisting of multiseptate hairs which have outgrowths from cells near the base and sometimes also from other cells. Apex of main *rachis* of fronds resting periodically while each pair of lateral branch-systems develops; primary rachis-branches repeatedly branched pseudo-dichotomously (forked), the apex between each pair of branches usually permanently dormant, the members of a pair equal or unequal; a short *stipule-like* lobed *leaflet* usually present at the base of each primary rachis-branch, these leaflets growing upwards and protecting the temporarily dormant apex of the main rachis (smaller stipule-like leaflets sometimes also present at forks of the lateral branch-systems); a pair of accessory branches, bearing a lamina like that of the ultimate branches, present at some of the forks of the lateral branch-systems, on the outside of the fork (usually attached just above it) and deflexed; apart from stipular leaflets and accessory branches, only the ultimate branches leafy. Ultimate branches bearing throughout a deeply pinnatifid *lamina*, the segments of the lamina usually entire, each with costule bearing lateral veins which are forked at least twice; *sori* one to each vein-group on an acroscopic branch (rarely also on a basiscopic branch), each of 8–15 or



Fig. 11. *Dicranopteris curranii* COPEL. Harau gorge, near Pajakumbuh, W. Sumatra, c. 500 m (MEIJER, Jan. 1958).

more sporangia without paraphyses, the sporangia smaller than in *Gleichenia*; spores monolete or trilete.

Distr. and Ecol. Thicket-forming ferns, abundant in open places throughout the wetter parts of the tropics and subtropics, especially characteristic of equatorial lowlands (the species of *Gleichenia* being almost exclusively mountain plants in Malaysia).

Notes. There are two well-marked subgenera, *Dicranopteris* (pantropic) and *Acropterygium* (one species, in tropical America; no accessory branches, rhizome with solenostele).

The subgenus *Dicranopteris* is much more diversified in Malaysia than in any other part of the world. A small group of species may be clearly distinguished by their monolete spores. Almost all other specimens are at present regarded as belonging to a polymorphic species, *D. linearis*. Some of the varieties of *D. linearis* are more clearly distinct than others, and probably should be recognized as species. They

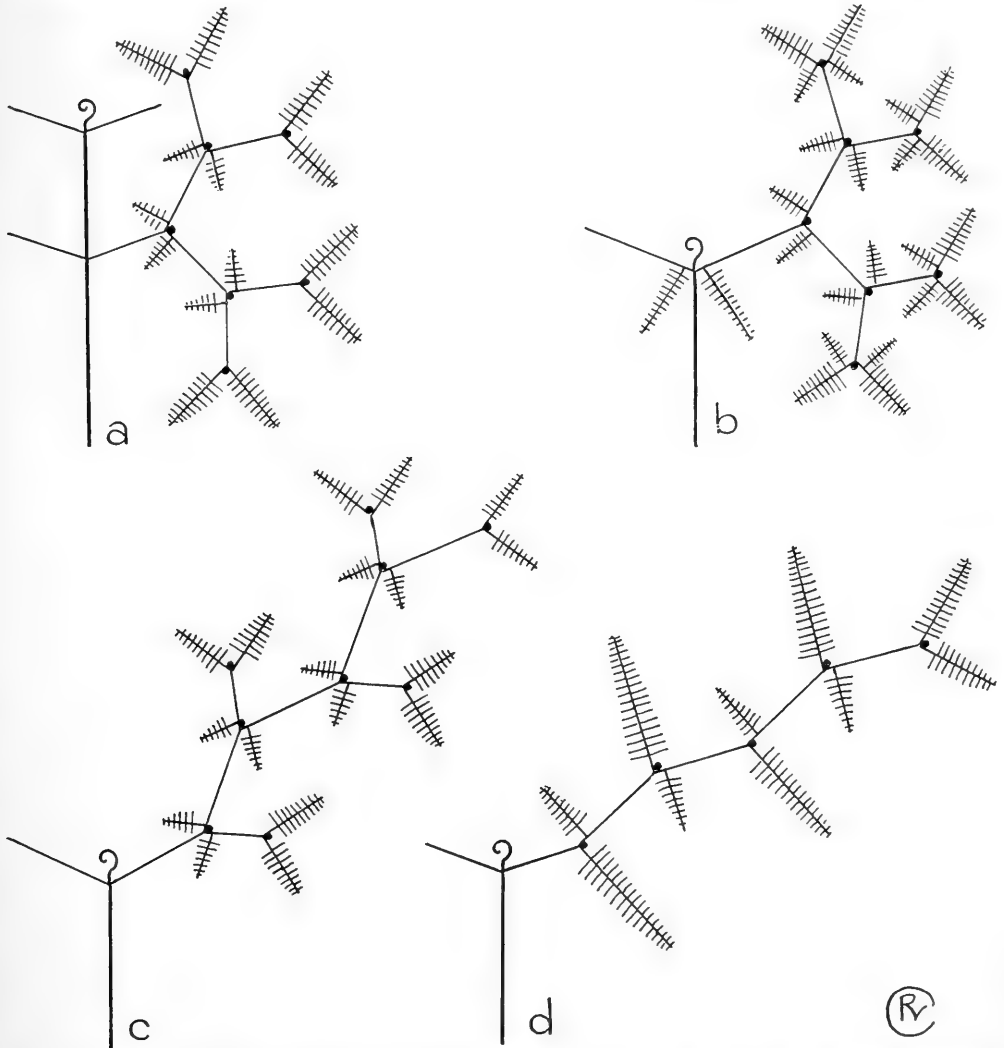


Fig. 12. Diagrams showing variations of branching-habit in *Dicranopteris*. a. Basic habit, found in *D. linearis* (BURM. f.) UND. var. *linearis*, *D. pubigera* (BL.) NAKAI, and *D. curranii* COPEL., b. accessory branches present at ultimate forks, as in *D. linearis* var. *montana* HOLT. and var. *tetraphylla* (ROS.) NAKAI, c. alternate unequal forking, as in *D. linearis* var. *subpectinata* (CHRIST) HOLT., var. *alternans* (METT.) HOLT., and var. *subspeciosa* HOLT., d. special development of c, found only in *D. speciosa* (PRESL) HOLT.





Fig. 13. *Dicranopteris* brake in an old crater swamp at c. 1200 m, Gajo Lands, N. Sumatra, surrounded by pole wood forest consisting mostly of *Ilex cymosa* (1937).

need, however, to be more clearly characterized from field studies. The existence of a triploid hybrid (see note below on cytology) indicates that it is probably impossible to refer every plant to a clearly defined variety.

Four varieties of *D. linearis* have the common character of invariably producing accessory branches at the bases of ultimate branches; in other characters they differ considerably from each other and do not form a natural group. Another variety having this character occurs commonly in west tropical Africa, but no such variety has been found in east Africa.

Cytology (observations by I. MANTON). Haploid chromosome number of *D. curranii* COPEL. (Singapore) is 39. *D. linearis* (apparently the normal form of the species) in Ceylon is either diploid ( $n = 39$ ) or tetraploid ( $n = 78$ ); a plant of *D. linearis* sent to Kew from Singapore is a sterile triploid.

#### KEY TO THE SPECIES

1. Spores monolete. The two branches at each fork equal; either lowland plants with ultimate branches 9–12 cm wide, or mountain plants. First fork of each vein at its very base.
2. Lamina not very thick nor with the veins grooved on the lower surface.



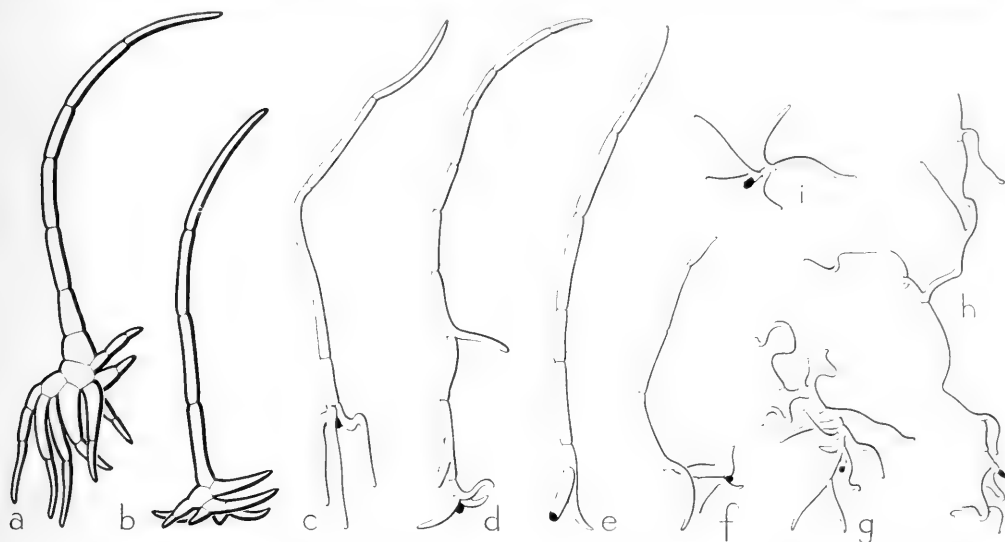


Fig. 14. Hairs of *Dicranopteris*, all  $\times 60$ . Except in fig. a and b the cell of attachment is shown, black.—*D. curranii* COPEL. a. Hair from base of costa. — *D. clemensiae* HOLT. b. One of the rigid, shining hairs from lower surface of costa, c. thin-walled hair from costule. — *D. pubigera* (BL.) NAKAI. d-e. Hairs from costule, lower surface. — *D. linearis* (BURM. f.) UND., hairs from lower surface of costules: f. var. *subferruginea* (HIERON.) NAKAI, g. var. *linearis*, h. var. *subspeciosa* HOLT., i. var. *alternans* (METT.) HOLT.

3. Ultimate branches commonly 40 cm long and 9–12 cm wide; lower surface almost glabrous.
  1. *D. curranii*
3. Ultimate branches not over 7 cm wide; lower surface of costae and costules rather persistently hairy.
  4. Ultimate branches 30–55 cm long, 5–7 cm wide; costae at first with many shining hairs (1–1½ mm long) throughout . . . . . 2. *D. clemensiae*
  4. Ultimate branches 15–25 cm long, 2.7–5 cm wide; costae with such hairs near base only.
    3. *D. pubigera*
2. Lamina very thick, the veins grooved on the lower surface . . . . . 3. *D. pubigera*
1. Spores trilete. Branches at a fork in many cases unequal; ultimate branches to c. 6 cm wide. Veins never grooved on lower surface; fork of each vein distinctly above the base.
  5. At each fork, except primary and ultimate ones, one branch leafy and without accessory branch, the other branch not leafy and with an accessory branch . . . . . 4. *D. speciosa*
  5. At each fork, except (in most cases) an ultimate one, a pair of accessory branches present.
    5. *D. linearis*

1. *Dicranopteris curranii* COPEL. Philip. J. Sc. 81 (1952) 4; HOLT. Reinwardtia 4 (1957) 274.—*Gleichenia hermannii* var. *venosa* BL. incl. also var. *tenera* BL. En. Pl. Jav. (1828) 249.—*Gleichenia dichotoma* var. *tenera* METT. in Miq. Ann. Mus. Bot. Lugd. Bat. 1 (1863) 50.—*Gleichenia dichotoma* var. *malayana* CHRIST, Ann. Jard. Bot. Btzig 15 (1898) 77.—*Gleichenia linearis* var. *malayana* v. A. v. R. Handb. (1908) 59; Suppl. (1917) 84; HOLT. Rev. Fl. Mal. 2 (1955) 70.—*D. lessonii* NAKAI, Bull. Nat. Sc. Mus. Tokyo n. 29 (1950) 61, *quoad specim., excl. basion. Mertensia lessonii* A. RICH.—Fig. 11, 12a, 14a, 16.

Fronds large, strongly erect but not greatly elongate nor high-climbing; primary rachis-branches few times equally forked; ultimate branches commonly 40 cm long and 12 cm wide,

accessory branches at penultimate forks commonly 20–30 cm long and 7–10 cm wide; costules 5–7 mm apart; lamina-segments 3½–4½ mm wide above the base, texture firm, lower surface glaucous, usually quite glabrous apart from minute simple hairs on the veins, often pinkish on costae and lower parts of costules; veins slender, slightly prominent on lower surface but not on upper; stipular leaflets to 3 cm long at bases of primary branches; spores monolete.

Type: Curran, For. Bur. 19265, Laguna Prov., Luzon (H. Copel.; dupl. at US, P).

Distr. Malaysia: Sumatra, Malay Peninsula, W. Java, Lesser Sunda Islands (Flores), Borneo, Celebes, Philippines (Luzon).

Ecol. In thickets with varieties of *D. linearis*, from sealevel up to 1500 m.

Note. *Gleichenia weatherbyi* FOSBERG (Am. Fern J. 40, 1950, 140), from the Caroline Islands, is very near *D. curranii*, with similar spores, but is even larger, and much more hairy.

**2. *Dicranopteris clemensiae* HOLTT.** Reinwardtia 4 (1957) 275.—Fig. 14b-c.

Main rachis 7 mm or more diameter; primary branches twice equally forked, copious dark red rigid hairs very persistent near the forks; ultimate branches 30–55 cm long, 5–7 cm wide, the lowest outer segments of the lamina sometimes enlarged and more or less lobed; accessory branches at penultimate forks 16–18 cm long, 5 cm wide; stipular leaflets at base of primary branches 3 cm long, lobes 3 mm wide; costules of ultimate branches 5–6 mm apart; lamina-segments  $3\frac{1}{2}$  mm wide above the base, thin but firm; veins usually 3 times forked, first fork very close to the costule, very slightly prominent on both surfaces; stout dark red multicellular hairs (1– $1\frac{1}{2}$  mm long, with several basal branches) at first abundant all along lower surface of costae, at length deciduous leaving costae perceptibly rough; thinner and paler, dull rusty-brown, hairs at first abundant on costules, slightly crisped and with short unicellular branches near base only; sori of 10–15 sporangia, often two on a vein-group (on each of the outermost branches); spores monolete, c.  $32 \times 16 \mu$ .

Type: Clemens 28745, Mt Kinabalu (BM; dupl. at Bo, K, L, US).

Distr. Malaysia: N. Borneo (once collected, 1600 m).

**3. *Dicranopteris pubigera* (BL.) NAKAI.** Bull. Nat. Sc. Mus. Tokyo n. 29 (1950) 68; HOLTT. Reinwardtia 4 (1957) 274.—*Gleichenia hermannii* var. *pubigera* BL. En. Pl. Jav. (1828) 249.—*Gleichenia dichotoma* var. *pubigera* METT. in Miq. Ann. Mus. Bot. Lugd. Bat. 1 (1863) 50.—*Gleichenia linearis* var. *pubigera* v. A. v. R. Handb. Suppl. (1917) 85.—*Mertensia spissa* (non FÉE) var. *pubigera* NAKAI, Bot. Mag. Tokyo 39 (1925) 180.—Fig. 12a, 14d-e, 15a-b.

Primary rachis-branches 2–4 times equally or subequally forked; ultimate branches 15–25 cm long, 3–8 cm wide; costules  $4\frac{1}{2}$ –6 mm apart; lamina-segments c. 4 mm wide when flattened, thick and rigid when dry and usually with edges reflexed; lower surface not glaucous, the costules at first covered rather densely with coarse dull rusty flexuous hairs and also some rigid shining hairs; veins grooved on the lower surface when the lamina is very thick, on thinner leaves hardly grooved, pale but not raised on the upper surface; spores monolete.

Type: Blume, Java (L; dupl. at K, P).

Distr. Malaysia: Sumatra, Java, and Lesser Sunda Islands (Bali, Lombok, Flores).

Ecol. Abundant in open scrub and in clearings in mountain forest, forming dense thickets, 1100–3000 m.

Note. The extreme forms of this species, one with very thick lamina with veins grooved on the lower surface, the other with thinner lamina and veins

not distinctly grooved, appear very different (the former is larger as well as thicker) but there are intermediates. The differences may in part be connected with altitude and exposure; no observations have been made.

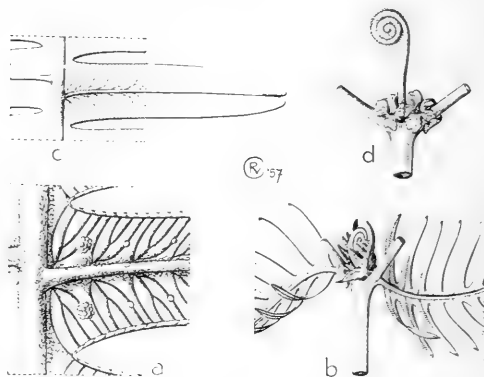


Fig. 15. *Dicranopteris pubigera* (BL.) NAKAI. a. Lower surface of part of frond (veins grooved),  $\times 4$ , b. a main fork with stipular leaflets and accessory branches,  $\times \frac{1}{2}$ . — *D. speciosa* (PRESL) HOLTT. c. Part of frond to show venation,  $\times 2$ , d. main fork showing stipular leaflets,  $\times \frac{1}{2}$ .

**4. *Dicranopteris speciosa* (PRESL) HOLTT.** Reinwardtia 4 (1957) 273.—*Hicriopteris speciosa* PRESL, Epim. Bot. (1851) 27.—*Gleichenia opposita* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 11 (1913) 13; HOLTT. Rev. Fl. Mal. 2 (1955) 70, f. 14 F.—*Gleichenia parallela* RIDL. J. Mal. Br. R. As. Soc. 4 (1926) 3.—*D. opposita* NAKAI, Bull. Nat. Sc. Mus. Tokyo n. 29 (1950) 68.—Fig. 12d, 15c-d.

Primary rachis-branches several times very unequally forked; at each fork the smaller branch unbranched and leafy throughout, commonly 20–25 cm long and 4–5 cm wide, with no accessory branch, the larger branch continuing almost the same straight line as the larger branch from the previous fork and bearing an accessory branch 12–15 cm long and  $3\frac{1}{2}$  cm wide (this accessory branch almost opposite the simple leafy branch of the fork); ultimate fork formed by two normal leafy branches without accessory branches; irregularities from this basic scheme occasionally present; lamina-segments  $3\frac{1}{2}$ –4 mm wide, flat and rather rigid, separated by very narrow sinuses, apices often retuse; veins distinctly prominent on the upper surface; lower surface more or less glaucous, the costules when young rather densely covered with fine pale entangled woolly hairs, some similar hairs on veins; some dark reddish, rigid, shining hairs, like those on resting apices, also at first present on costae and costules; sori as in *D. linearis*; spores trilete.

Type: collector unknown, "Pendschab" (PRC). Perhaps from Penang.

Distr. Malaysia: Sumatra, Malay Peninsula, Moluccas (Sula Isl.: P. Mangoli).

Ecol. Growing with *D. linearis* on the edges of forest, 100–600 m.

Note. The remarkable pseudo-pinnate lateral branch-systems of this species were described in detail by PRESL, but because he compared these branches to *Gleichenia glauca* (THUNB.) HOOK. later authors thought he was describing a species of *Gleichenia* subg. *Diplopterygium* and conse-

quently used the generic name *Hicriopteris* in a wrong sense.

5. *Dicranopteris linearis* (BURM. f.) UNDERW. Bull. Torr. Bot. Cl. 34 (1907) 249; HOLTT. Reinwardtia 4 (1957) 275.—*Polypodium dichotomum* THUNB. Fl. Jap. (1784) 338, t. 37.—*Gleichenia dichotoma* HOOK. Sp. Fil. 1 (1844) 6; RACIB. Fl. Btzig 1 (1898) 13.—Fig. 12, 14f-i.

#### KEY TO THE VARIETIES

1. Accessory branches not always present at ultimate forks.
2. Branches at each fork of a lateral branch-system approximately equal; lateral branch-systems forked 1–3 times.
3. Costules less than 5 mm apart, their lower surface with some persistent hairs.
4. Hairs not persistent on lower surface of veins . . . . . 1. var. *linearis*
4. Hairs persistent along lower surface of veins.
5. Hairs long, very finely woolly and entangled; no distinct separate hairs present.
5. Hairs coarse, shorter, more or less entangled on costules, some distinctly separate on veins.
2. var. *ferruginea*
3. var. *subferruginea*
3. Costules 5–7 mm apart, their lower surface glabrous.
6. Lamina thick and rigid . . . . . 4. var. *rigida*
6. Lamina thin . . . . . 5. var. *latiloba*
2. Branches at successive forks alternately unequal; lateral branch-systems on well-grown plants forked at least 3 times.
7. Lower surface quite glabrous and persistently pale glaucous; lamina thin 6. var. *subpectinata*
7. Lower surface more or less persistently hairy, less strongly glaucous (often losing glaucous character on drying); lamina firm.
8. Hairs very slender, their long branches much crisped and entangled; no separate short hairs.
9. Hairs copious, at first covering whole lower surface, persistent along the veins, rusty when dry; edges of lamina strongly reflexed when dry . . . . . 2. var. *ferruginea*
9. Hairs not covering whole lower surface, persistent only on costules, pale when dry; edges of lamina not much reflexed when dry.
10. Angle of secondary and later forks not more than a right angle . . . . . 7. var. *subspeciosa*
10. Angle of secondary and later forks more than a right angle . . . . . 8. var. *inaequalis*
8. Hairs coarser and shorter, some more or less crisped and entangled but separate short hairs also present.
11. Hairs confined to bases of some of the costules . . . . . 1. var. *linearis*
11. Hairs more abundant on costules, and some also on veins.
12. Hairs persistently rust-coloured, copious all along veins. . . . . 3. var. *subferruginea*
12. Hairs pale on dried specimens, sparse on the veins; W. Malaysia . . . . . 9. var. *alternans*
1. Accessory branches always present at ultimate forks.
13. Accessory branches, especially the lower ones, distinctly below the fork; branches at successive forks alternately somewhat unequal . . . . . 10. var. *demota*
13. Accessory branches opposite the fork or distinctly above it; branching usually equal at all forks.
14. Ratio of length to width of branches commonly 2 : 1; costules c. 3 mm apart, segments of lamina 2½–3 mm wide . . . . . 11. var. *tetraphylla*
14. Ratio of length to width greater; costules more widely separated.
15. Costules on ultimate branches 5–7 mm apart; texture subcoriaceous; lower surface quite glabrous; accessory branches at ultimate forks almost opposite the fork . . . . . 12. var. *montana*
15. Costules on ultimate branches 3½–4½ mm apart; texture thin; some rusty hairs often on lower surface; accessory branches at ultimate forks 3–4 mm above the fork . . . . . 13. var. *altissima*

1. var. *linearis*.—*Polypodium lineare* BURM. f. Fl. Ind. (1768) 235, t. 67 f. 2.—*Gleichenia hermannii* R. BR. Prod. (1810) 161.—*Gleichenia dichotoma* var. *normalis* METT. in Miq. Ann. Mus. Bot. Lugd. Bat. 1 (1863) 50; RACIB. Fl. Btzig 1 (1898) 13.—*Mertensia pteridifolia* PRESL, Abh. (K.) Böhm. Ges. Wiss. M.-N. Cl. V, 5 (1848) 339; Epim. Bot. (1851) 23, t. 14.—*Gleichenia linearis* CLARKE, Trans. Linn. Soc. Bot. 1 (1880) 428; v. A. v. R. Handb. (1908) 59 *pro* var. *normalis*; Suppl.

(1917) 84, *ditto*; HOLTT. Rev. Fl. Mal. 2 (1955) 70, *ditto*.—Fig. 12a, 14g, 16.

Primary rachis-branches commonly 2 or 3 times forked, the two branches at all forks equal or nearly so (not regularly alternately unequal); stipular leaflets at bases of primary branches c. 1 cm long, lobed near the base only; ultimate branches 15–25 cm long, 4–6 cm wide; lamina-segments 2½–3 mm wide, separated by rather wide sinuses, texture very firm; lower surface slightly

glaucous; veins slightly prominent on lower surface and bearing very short simple hairs, not prominent on upper surface; some persistent much-branched rusty hairs on costules; *spores* trilete.

Type: Ceylon, Herb. Delessert (G).

Distr. Tropical and subtropical Africa, Asia, Malaysia, Australasia, and Polynesia.

Ecol. Thicket-forming but not high-climbing, from sealevel to 1400 m.

Note. *Polypodium dichotomum* THUNB. was described from Japan, and as noted by NAKAI (*l.c.*) is not quite identical with *Polypodium lineare* BURM. (BURMAN's specimens, preserved at Geneva, are from Ceylon). I have therefore ranked it as a *Dicranopteris linearis* var. *dichotoma* (Reinwardtia 4, 1957, 277). The lamina of the fronds is thinner than in var. *linearis* and the veins are prominent on the upper surface. This may be connected with the fact that (at least in part of its range) the fronds of var. *dichotoma* only last for one season, dying in the winter, whereas those of var. *linearis* grow for an indefinite period which is usually not climatically limited. Var. *dichotoma* apparently occurs also in China and probably in the Sikkim region; field studies in these regions are needed to establish clear distinctions between var. *linearis* and var. *dichotoma*.

2. var. *ferruginea* (BL.) HOLTT. Reinwardtia 4 (1957) 278.—*Gleichenia ferruginea* BL. En. Pl. Jav. (1828) 249; METT. Ann. Mus. Bot. Lugd. Bat. 1 (1863) 50.—*Gleichenia dichotoma* var. *ferruginea* RACIB. Fl. Btzig 1 (1898) 13.—*Gleichenia linearis* var. *ferruginea* v. A. v. R. Handb. (1908) 59; Suppl. (1917) 85.—*Dicranopteris ferruginea* COPEL. Philip. J. Sc. 75 (1941) 349, not *Mertensia ferruginea* DESV. 1811.

Lateral branch-systems of small plants symmetrically forked twice, on larger plants forked to 3 or more orders, branches at successive forks alternately unequal; ultimate branches 15–20 cm long, 3–5 cm wide; costules 4–5 mm apart; segments of lamina brittle when dry, with recurved edges, when flattened c. 2½ mm wide above the base, lower surface covered with very fine floccose entangled pale rusty hairs (c. 10 μ diam.) which are attached mainly along the veins, the veins thus persistently hairy on old fronds; stiff hairs present on dormant apices only; upper surface smooth, the veins very distinct and slightly raised when dry; accessory branches not normally present at the ultimate forks, but the lowest basiscopic lobes of the ultimate branches usually larger than the rest, their edges more or less lobed.

Type: Blume, Java (L).

Distr. Malaysia: Java, Celebes, Moluccas, New Guinea.

Ecol. Altitude 1000–2500 m.

3. var. *subferruginea* (HIERON.) NAKAI, Bull. Nat. Sc. Mus. Tokyo n. 29 (1950) 66.—*Gleichenia linearis* var. *subferruginea* HIERON. ex BRAUSE, Bot. Jahrb. 56 (1920) 209.—Fig. 14f.

Like var. *linearis* but perhaps more often with unequal branches at the more distal forkings,

veins somewhat prominent on upper surface, veins on the lower surface rather persistently hairy, the hairs rusty, rather coarse (diam. c. 25 μ) and much-branched, not finely woolly nor forming a continuous entangled web as in var. *ferruginea*.

Type: Ledermann 6926, New Guinea (B).

Distr. Queensland, Polynesia (Fiji, Samoa), and East Malaysia: Celebes, Moluccas, New Guinea.

Ecol. From sealevel to 1200 m.

Note. It is probable that this variety is much more abundant than var. *linearis* in New Guinea and regions further eastwards. The hairs on the lower surface of the veins are of the same general character as those of var. *linearis*, but much more copious; they are more abundant on plants at higher altitudes than near sealevel, and possibly abundance of hairs also depends on degree of exposure.

4. var. *rigida* (BL.) HOLTT. Reinwardtia 4 (1957) 277.—*Gleichenia hermannii* var. *rigida* BL. En. Pl. Jav. (1828) 249.—*Mertensia crassifolia* PRESL, Abh. (K.) Böhm. Ges. Wiss. M.-N. Cl. V, 5 (1848) 339; Epim. Bot. (1851) 23, t. 13.—*Gleichenia dichotoma* var. *rigida* METT. in Miq. Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 50.—*Gleichenia warburgii* CHRIST, Ann. Jard. Bot. Btzig 15 (1898) 78.—*Gleichenia linearis* var. *rigida* v. A. v. R. Handb. (1908) 59; Suppl. (1917) 84.—*Gleichenia crassifolia* COPEL. Philip. J. Sc. 1 (1906) Suppl. I 257.—*D. crassifolia* NAKAI, Bull. Nat. Sc. Mus. Tokyo n. 29 (1950) 57. (*Non Mertensia rigida* KZE 1834, *D. rigida* NAKAI).

Lateral branch-systems once or twice forked, members of all forks equal or nearly so; ultimate branches 15–25 cm long, 3–5½ cm wide; costules 5–6 mm apart; segments of lamina 4–5 mm wide above the base, thick and very rigid when dry with edges slightly reflexed, apices not or slightly retuse; lower surface quite glabrous from an early stage; veins broad, slightly prominent on lower surface, distinctly so on upper surface; *spores* trilete.

Type: Reinwardt, Tidore (L).

Distr. Malaysia: Moluccas (type from Tidore), Celebes, and Philippines (Mindanao, Luzon, Negros).

Ecol. Altitude 1500–3000 m.

Note. METTENIUS (and apparently also RACIBORSKI) referred some specimens of *D. pubigera* from Java to this variety of *D. linearis*.

5. var. *latiloba* HOLTT. Reinwardtia 4 (1957) 277.

Lateral branch-systems forked to about 4th order, branches at all forks subequal; stipular leaflets at bases of primary branches to 4 cm long, deeply and broadly lobed; ultimate branches c. 20 cm long, to 9 cm wide, the lowest segments of the lamina somewhat enlarged and deflexed but not pinnately lobed; costules c. 7 mm apart; segments 4–5 mm wide above the base, firm but not very thick, edges slightly sinuous, only reflexed when dry; lower surface quite glabrous apart from minute simple hairs; veins sometimes



Fig. 16. Thicket of *Dicranopteris* on edge of forest, Singapore. *D. curranii* COPEL. (large fronds) to left and right; *D. linearis* (BURM. f.) UND. var. *linearis* in centre; var. *subpectinata* (CHR.) HOLTT. to right of centre, below (HOLTUM, 1925).

pale and distinctly prominent on the upper surface, concolorous and only slightly prominent on lower surface.

Type: Merrill 975, Luzon (US; dupl. at P, U, F).

Distr. *Malaysia*: Philippines (Luzon, Negros, Mindanao), Celebes (?).

Ecol. Altitude 1000–1600 m.

6. var. *subpectinata* (CHRIST) HOLTT. Reinwardtia 4 (1957) 277.—*Gleichenia subpectinata* CHRIST, Bot. Tidsskr. 24 (1901) 111.—*Gleichenia pteridifolia* (non *Mertensia pteridifolia* PRESL) RIDL. J. Mal. Br. R. As. Soc. 4 (1926) 4.—*D. warburgii* (non *Gleichenia warburgii* CHRIST) sensu NAKAI, Bull. Nat. Sc. Mus. Tokyo n. 29 (1950) 70.—*Gleichenia linearis* var. *alternans* (non METT.) HOLTT. Rev. Fl. Mal. 2 (1955) 70 and frontispiece.—Fig. 12c, 16.

Lateral branch-systems several times forked, branches at successive forks alternately unequal, successive larger branches forming almost a straight line; ultimate branches 9–15 cm long, 2–3½ cm wide (sterile ones sometimes to 18 by 6 cm); lamina thin, lower surface pale glaucous and quite glabrous when mature; segments of

lamina gradually and rather evenly tapering from base to apex, the sinuses thus narrowly triangular; costules 4–4½ mm apart; veins slightly raised on both surfaces, concolorous with lamina; the smaller accessory branches usually attached 3–5 mm above the forks (sometimes lacking or reduced at penultimate forks).

Type: Schmidt, Koh Chang Isl. (P).

Distr. Lower Siam (type from Koh Chang Island), and *Malaysia*: Sumatra, Malay Peninsula, Lingga Archipelago, Banka, Borneo.

Ecol. On edges of forest, in thickets with var. *linearis* and other varieties, climbing higher than var. *linearis*, from sealevel up to 700 m.

7. var. *subspeciosa* HOLTT. Reinwardtia 4 (1957) 278.—Fig. 12c, 14h.

Resembling *D. speciosa* in shape, texture etc. of ultimate branches and in hairiness, but lateral branch-systems branched as in var. *alternans*.

Type: Topping 1516, Mt Kinabalu, Kiau (US; dupl. at SING).

Distr. *Malaysia*: Sumatra, Malay Peninsula, Borneo, and Philippines (Mindanao, Mindoro, Luzon).

Ecol. On edges of forest, in thickets with other varieties, 0–1400 m.

8. *var. inaequalis* (ROSENST.) HOLTT. Reinwardtia 4 (1957) 278. — *Gleichenia linearis var. inaequalis* ROSENST. in Fedde, Rep. 13 (1915) 212; v. A. v. R. Handb. Suppl. (1917) 85.

Shape and venation of *lamina-segments*, and hairiness, as in *var. subspiciosa*, differing as follows in branching: forking in lateral branch-systems alternately very unequal, the angle of the forks much more than a right angle (sometimes nearly 180°), the smaller branch at a fork simple or once forked and sometimes lacking an accessory branch, the accessory branch on the larger branch attached 5–10 mm above the base of that branch.

Type: J. Winkler 114, Batakerland, Sumatra (H. Selim Birger, S).

Distr. *Malaysia*: Sumatra, Malay Peninsula (three collections in all).

Ecol. Altitude c. 1400 m.

9. *var. alternans* (METT.) HOLTT. Reinwardtia 4 (1957) 278. — *Gleichenia dichotoma var. alternans* METT. in Miq. Ann. Mus. Bot. Lugd. Bat. 1 (1863) 51. — *Gleichenia linearis var. alternans* v. A. v. R. Handb. Suppl. (1917) 84. — **Fig. 12c, 14i.**

Very similar to *var. linearis* in texture, shape, and hairiness of the ultimate branches, but lateral branch-systems several times forked, the branches at successive forks alternately unequal about as in *var. subpectinata*, differing from the latter in larger somewhat hairy ultimate branches of much firmer texture.

Type: Korthals, Sumatra (L).

Distr. *Malaysia*: Sumatra, Malay Peninsula, Borneo.

Ecol. Apparently not common, but needs field study; perhaps only a growth-form of *var. linearis*; from sealevel up to 500 m.

10. *var. demota* HOLTT. Reinwardtia 4 (1957) 275.

Lateral branch-systems several times forked, branches at successive forks alternately unequal; accessory branches normally present at all ultimate forks; ultimate branches to 18 cm long, 3–6 (rarely to 7) cm wide; costules 5 mm apart; *lamina* thin, lower surface glabrous and probably glaucous; veins distinctly prominent on upper surface and slightly so on lower surface; accessory branches at the lower forks attached distinctly below the fork.

Type: Clemens 29535, Mt Kinabalu, 5600 ft (K; dupl. at BM, Bo, L, US).

Distr. *Malaysia*: N. Borneo, Ceram (doubtful), New Guinea.

Ecol. Altitude 1600–2250 m.

11. *var. tetraphylla* (ROSENST.) NAKAI, Bull. Nat. Sc. Mus. Tokyo n. 29 (1950) 67. — *Gleichenia*

*linearis var. tetraphylla* ROSENST. in Fedde, Rep. 13 (1914) 213; v. A. v. R. Handb. Suppl. (1917) 84. — **Fig. 12b.**

Lateral branch-systems several times forked, branches at successive forks alternately somewhat unequal; penultimate branches less than 1 mm diam. when dry; accessory branches always present at bases of ultimate branches; ratio of length to width of ultimate and accessory branches about 2 : 1; ultimate branches to 12 cm long and 7 cm wide, costules 3 mm apart, *lamina* very thin and strongly glaucous on the lower surface, quite glabrous; veins very slender, distinctly prominent on both surfaces.

Type: J. Winkler 136, Batakerland, Sumatra (H. Selim Birger, S).

Distr. Indo-China, Hainan, Kwangtung, in *Malaysia*: Sumatra.

Ecol. Altitude 1250 m.

Note. The specimens from China have ultimate branches proportionately rather narrower than those from Sumatra, but are otherwise similar.

12. *var. montana* HOLTT. Reinwardtia 4 (1957) 276. — *Gleichenia linearis var. montana* HOLTT. Rev. Fl. Mal. 2 (1955) 69, descr. angl. — **Fig. 12b.**

Lateral branch-systems several times equally forked; ultimate branches 15–25 cm long, 3½–6 cm wide; costules (5)–6–7 mm apart; *lamina* coriaceous, glabrous and glaucous on the lower surface, veins rather strongly prominent on both surfaces; accessory branches, about half as long as the ultimate branches, always present at the bases of ultimate branches.

Type: Molesworth Allen 2720 (SING).

Distr. Ceylon, S. India, Sikkim, in *Malaysia*: Sumatra, Malay Peninsula, Java, Borneo, and Moluccas (Ternate).

Ecol. On the edges of forest and in clearings, with other varieties of *D. linearis* and with other members of the family; 1000–1600 m.

13. *var. altissima* HOLTT. Reinwardtia 4 (1957) 276. — *Gleichenia linearis var. altissima* HOLTT. Rev. Fl. Mal. 2 (1955) 69, descr. angl.

Sometimes very high-climbing, the main *rachis* to 10 mm diameter; lateral branch-systems equally forked 4 or 5 times; ultimate branches to 15 cm long and 3 cm wide; costules 3½–4½ mm apart; *lamina* thin, lower surface glaucous, glabrous apart from scattered rusty hairs on lower surface of costules; veins prominent on upper surface, not on lower surface; accessory branches always present at bases of ultimate branches.

Type: Corner 31447, Johore, Malay Peninsula (SING; dupl. at K, L).

Distr. *Malaysia*: Malay Peninsula, Philippines (Palawan, Luzon), Moluccas (Talaud), New Guinea, and Solomon Islands.

Ecol. At low altitudes, climbing on edges of forest.

## SCHIZAEACEAE (R. E. Holttum, Kew)

Rhizome usually short-creeping with closely-placed fronds, less often wide-creeping or somewhat erect, the young parts covered with thick septate hairs (except *Mohria*, not Malaysian), structure dorsiventral or radial, vascular strand in Malaysian genera a protostele (medullated in *Schizaea*). Fronds of very varied structure, their branching showing varying gradations from dichotomous to pinnate; veins usually free; *sporangia* borne on specialized segments of the fronds (soriophores) except in the non-Malaysian *Mohria*. *Soriophores* at the ends of veins of fertile leaflets (*Lygodium*), or in small pinnate groups at the apex of a frond or of its branches (*Schizaea*), or confined to special branches of the frond (*Anemia*, not Malaysian). *Sporangia* arising marginally but becoming superficial due to subsequent extra-marginal growths, large, borne on short massive stalks or sessile, with an almost apical annulus of a single row of elongate thickened cells, dehiscing on a line from annulus to base. *Spores* trilete or monolete (*Schizaea* only), without perispore, the surface usually sculptured. *Gametophytes* filamentous in *Schizaea*, thalloid in other genera, symmetrical or not.

**Distribution.** The Malaysian genera *Schizaea* and *Lygodium* are pantropic with a few outlying species of both in temperate regions (U.S.A., S. Africa, Chile, Japan, and New Zealand). *Anemia* has its main distribution in tropical America, with a few species in Africa and one in southern India. *Mohria* is confined to southern and eastern Africa and the Mascarene Islands.

**Fossils.** The older fossils belong to extinct genera, which are quite different in frond-form from living members of the family; their relationship to these living members is shown only by their *sporangia* and spores. The Upper Carboniferous genus *Senftenbergia* has been most recently and fully described by RADFORTH (Trans. R. Soc. Edinb. 59, 1938, 385–396; *ibid.* 1939, 745–761). The fronds were bipinnate-tripinnatifid, comparable in size with those of *Cyathea* of today, with sterile and fertile parts alike in shape of lamina; the rhizome is not known. The *sporangia*, attached to the edge of the lamina by very short stalks, were similar in shape to those of the living genus *Anemia* but differed in having an annulus of 2–5 rows of cells, in at least one case not sharply differentiated from the rest of the *sporangial* wall. The Jurassic genus *Klukia* had fronds of similar form, but the *sporangia* had an annulus of a single row of cells, much as in *Anemia*. C. F. REED has made the most recent summary of fossil forms in the family (Bol. Soc. Brot. 21, 1947, 71–197); he includes also the genera *Tempskya*, *Acrostichopteris*, *Pelletiera*, and *Schizaeopsis*, from Upper Jurassic and Cretaceous horizons, but *sporangia* of these have not been seen. Fossils of the living genera *Anemia*, *Lygodium*, and *Schizaea* have been found in late Cretaceous and early Tertiary rocks in Europe and North America (REED, *l.c.*; CHANDLER, Bull. Br. Mus. Nat. Hist., Geol., 2, 1955, 291–314; SELLING, Act. Hort. Gotob. 16, 1944, 1–112); fossils of *Schizaea* have also been found in Eocene of SE. Australia and Pliocene in New Guinea (COOKSON, Proc. R. Soc. Victoria n.s. 69, 1957, 41). Fossils of *Anemia* and *Lygodium* include good leaf-impressions and *sporangia*; those of *Schizaea* are confined to spores. One species of *Schizaea* is also known from fossils of Quaternary age in Hawaii.

**Ecology.** *Lygodium* plants are twining climbers, mainly in secondary vegetation (fig. 6, 10), producing fertile leaflets on parts exposed to the brightest light (in most cases, to full sunlight). Fronds of the larger species may climb to a height of 10 m, but others only to 2–3 m. In regions where there is a prolonged dry season the plants may be confined to wet ground. *L. microphyllum*, *L. polystachyum* and *L. salicifolium* have caducous leaflets which fall when old. Whether plants are ever quite bare of leaflets in dry seasons is not recorded; certainly the rhizomes have no power of resisting considerable drought, and most plants are evergreen. *L. japonicum* occurs outside Malaysia in decidedly seasonal climates, and in Malaysia does not occur in the uniformly wet region of Sumatra, Malaya and Borneo. *L. polystachyum*, native of the seasonal climate of the region from northern Malaya to Burma and Indochina, is only found in shady forest; possibly this is also true of *L. merrillii*. All species of *Lygodium* in Malaysia are lowland plants, the highest altitude record being little over 1000 m, apart from *L. japonicum* (to 2500 m).

*Schizaea* plants are all small, and occur in poor acid sandy or peaty soils where the vegetation is rather open (fig. 1, 2), apart from *S. digitata*, which always occurs in light to moderate shade. *S. fistulosa* is a high mountain plant, *S. malaccana* on exposed ridges at moderate elevations, the other species in low country. *S. inopinata* occurs only on limestone. *S. wagneri* and *S. spirophylla* are reported as growing in moss-cushions on trees.

**Vegetative morphology.** Both *Lygodium* and *Schizaea* are specialized, in quite different ways;





Fig. 1. Unusually dense stand of *Schizaea dichotoma* (L.) SM. on very poor sandy podsol, under shrubs near Pasir Pandjang, west coast of Borneo (DUNSELMAN, 1936).

as above indicated, they are adapted to peculiar habitat-conditions. It is probably significant that neither is represented by fossils earlier than late Cretaceous or Eocene. The sorophores of both genera (and of *Anemia*) are perhaps reduced modifications of the lobes of fertile leaflets of ancestral ferns with fronds like those of *Senftenbergia*. The photosynthetic function of such lobes is transferred in both genera to a lamina developed from the wing of the rachis which occurs throughout the family (see further notes under the genera); such development is much more extensive in *Lygodium* than in *Schizaea* (for a discussion of transference of function, see CORNER in Journ. Linn. Soc. Bot. 56, 1958, 33-48).

Fronds of *Schizaea* are either unbranched (the ultimate condition of reduction) or symmetrically dichotomously branched. Fronds of young plants of *Lygodium* are dichotomously branched, but later fronds develop an elongate sympodial climbing rachis by means of a series of alternate unequal dichotomies. The short branch at each dichotomy of a climbing rachis has a pair of opposite secondary branches beyond which it is dormant (HOLTUM, Phytomorphology 7, 1957, 152). The dormant apices may grow if there is injury to a distal part of the frond. Similar, but not identical, dormancy occurs in the families *Gleicheniaceae* and *Matoniaceae*. Periodic dormancy of apices occurs in *Dennstaedtia*, *Hypolepis* and *Paesia*, which are perhaps derivatives of *Schizaeaceae*.

PRANTL investigated the development of sorophores in *Schizaeaceae*, and stated that the sporangia were marginal in origin (Untersuch. z. Morph. der Gefäßskrypt. II, 1881). DIELS doubted PRANTL's observations (in Engler, Pflanzenfam. 1, 4, 1900, 356-372), but later workers confirmed them (BOWER, The Ferns 2, 1926, 163-165). The lamina of the sorophores, and the separate indusia for each of the sporangia in *Lygodium*, are later extra-marginal developments.

Sporangia and spores. The sporangia are the most distinctive feature of the family; they are well illustrated by PRANTL for all genera and his drawings have been frequently copied. The sporangia are large, almost or quite sessile, and all have an almost apical annulus with a longitudinal line of dehiscence. Those of *Lygodium* are peculiar in having an asymmetrically placed lateral attachment. The spores are in most cases rather elaborately sculptured on the surface, and are often specifically diagnostic (see further discussion under the genera).

Gametophyte. The gametophyte of *Schizaea* is filamentous, with antheridia and archegonia on special short branches; some cells have an endophytic fungus. Other genera have more normal gametophytes, sometimes with asymmetric growth; their antheridia are large, and they show some other primitive features (for references up to 1926, see BOWER, *l.c.* 170). Most observations of gametophytes have been of non-Malaysian species.



**Cytology.** The only records are by MANTON & SLEDGE (Phil. Trans. R. Soc., B, 238, 1954, 142-143) and LOVIS (Nature 181, 1958, 1085). *Lygodium scandens* (*L. microphyllum* of present work) in Ceylon had  $n = 30$ . *L. circinnatum* in Ceylon had  $n = 58$ , but a plant in cultivation at Kew had  $n = 29$ . A plant of *L. japonicum* at Kew also had  $n = 58$ . The basic number in *Anemia* is 38; a naturalized plant in Ceylon was tetraploid, a plant in cultivation at Kew diploid. *Schizaea asperula* WAKEF. in New Zealand had  $n = 77$  (LOVIS, *l.c.*); the same number was also found by LOVIS (unpublished) for *S. dichotoma* in New Zealand. In Ceylon LOVIS found that *S. digitata* had a very high number ( $n = 325 \pm 30$ ). These figures indicate that polyploidy is not uncommon in the family, and that the extreme reduction of plant-form in *Schizaea* may be associated with high polyploidy.

**Anatomy.** The fullest account of anatomy in the family is by PRANTL (*l.c.*); later works are cited by BOWER. The rhizome of *Lygodium* has a solid protostele; the rachis of the climbing frond has also a compact vascular strand (not C-shaped), with very large tracheids in the xylem, no doubt in adaptation to its habit (a slender twining rachis carrying many leaflets, which thus needs a vascular system of capacity large in proportion to its area of cross-section). The rhizome of *Schizaea* has a more or less medullated protostele, and the stipe has a small compact vascular strand in which the xylem is reduced, more or less 3-armed as seen in cross-section. In both genera there is considerable development of sclerenchyma. The genera *Anemia* and *Mohria* have a more complex vascular anatomy. *Schizaea* shows specialization in the arrangement of stomata, the details of this varying from species to species.

**Economic importance.** The tough slender climbing rachises of *Lygodium* find various uses, either in their natural form, or prepared by splitting for finer purposes. They are used as a substitute for cord (e.g. for tying sheaves of rice), for plaiting into hats, bracelets, etc., for fastening the rims of sieves, and in other ways. There are records of the use of several species of *Lygodium*, and also of *Schizaea dichotoma*, for a great variety of medicinal purposes (see BURKILL, Dict. Econ. Prod. Mal. Pen. 1378, 1975; also HEYNE, Nutt. Pl. Ned. Ind. ed. 2, 96, 97), but no critical study of such uses has been made. Very young leaves of *Lygodium microphyllum* and *L. circinnatum* are eaten in Java (OCHSE, Veg. D.E.I. 1931, 655-657). The plants are also used (especially *Lygodium*) in magical ceremonies connected with house-building, rice culture, fishing, etc.

**Taxonomy.** The early history of the taxonomy of the genus *Lygodium* is very complex, for various reasons. LINNAEUS began badly by including references to three distinct species under his *Ophioglossum scandens* (the basis of *Lygodium scandens* Sw.); and he was unfortunate in having a poor specimen of a sterile frond of an immature plant on which to base his *O. flexuosum*. In the years immediately following 1800, several authors were independently studying specimens of *Lygodium*, and the following generic names were given: *Lygodium* SW., *Ugena* CAV., *Ramondia* MIRBEL, *Odontopteris* BERNH., *Gisopteris* BERNH. and *Hydroglossum* WILLD. (all in 1801), *Cteisium* MICHX (1803) and *Vallifilix* THOUARS (1809). The following names were also given to *Schizaea*: *Lophidium* RICH. (1792) and *Ripidium* BERNH. (1801). For a full bibliographic statement on these genera, and a discussion of their typification, see PICHISERMOLLI, Webbia 12 (1955) 4-36.

In the case of *Lygodium*, there is so much variation in leaflet-form, due to (a) age of plant, (b) environmental conditions, (c) height above ground from which specimen is taken, (and probably also to polyploidy and hybridization) that, even with ample material, it is not easy to define specific limits, and there was much confusion in the use of names by earlier authors. Different forms of the same species received different names, while in other cases two quite different species were confused under one name. WILLDENOW based his *Hydroglossum pinnatifidum* on two specimens, one sterile and one fertile, belonging to two quite distinct species, and his name, transferred to *Lygodium*, was subsequently used by different authors for both these species. For a detailed discussion of this subject, see ALSTON & HOLTUM, Reinwardtia 5 (1959) 11-22.

The only good monograph of the whole family is that of PRANTL (*l.c.*, 1881), whose very thorough morphological study (of material then available) laid a sound basis on which others, working on various aspects of the family and with new material, could build. DIELS (in Engler, Pflanzenfam.) followed PRANTL with little alteration, as did also CHRISTENSEN (Index Filicum, 1905). As regards nomenclature, PRANTL did not look fully into the typification of *L. scandens* (L.) Sw. and he did not follow some of our modern rules. Also he did not have good material (in a few cases he had no material) of some of the less common Malaysian species.

NAKAI published a survey of the whole family in 1937 (J. Jap. Bot. 13, 139-154). He divided it into the three families *Schizaeaceae*, *Lygodiaceae* and *Anemiaceae* (including *Mohria* in the last) and also raised some infra-generic groups to generic rank. This process was carried further by C. F. REED (Bol. Soc. Brot. 21, 1947, 71-197) who raised the rank of the whole group to that of an Order, *Schizaeales*, with families for the fossil as well as living representatives. He separated *Mohria* as a family distinct from *Anemia*, and raised further subdivisions of *Lygodium* and *Schizaea* to generic rank, but made no critical contribution to the understanding of species, nor any new basic morphological study. COPELAND (Gen. Fil. 1947) made little change from CHRISTENSEN's arrangement.

#### KEY TO THE GENERA

1. Fronds simple and linear, or dichotomously branched with linear branches (which in some non-Malaysian species are joined laterally), the sorophores borne laterally near the apex of the frond

or of its branches; no indusia. Spores monolete . . . . . 1. *Schizaea*

1. Fronds of young plants dichotomously branched, of older plants of indefinite growth with twining rachis, the rachis-branches variously branched and bearing leaflets which have sorophores at the ends of their veins; each sporangium protected by a separate indusium. Spores trilete 2. *Lygodium*

### 1. SCHIZAEA

SM. Mem. Ac. Turin 5 (1793) 419, *nom. cons.*—*Lophidium* RICH. Act. Soc. Hist. Nat. Paris 1 (1792) 114.—*Actinostachys* WALL. ex HOOK. Gen. Fil. (1842) t. 111; REED, Bol. Soc. Brot. 21 (1947) 130.—*Microschizaea* REED, l.c. 133.—**Fig. 1-4.**

Rhizome creeping or suberect, the young parts, and bases of stipes, covered with coarse septate hairs, vascular system a medullated protostele. *Stipes* erect, slender, narrowly winged towards apex in most species. *Frond* simple or dichotomously branched, lamina reduced to a narrow wing bearing a single (rarely double) row of stomata on the lower surface; two-celled glandular hairs frequent on the surface of fronds, the basal cells persistent and often forming small warts, distal cells shrivelling or falling when old or dried. *Sorophores* pinnately arranged at the apex of a frond or of its branches, each sorophore with a median ridge on its lower (abaxial) surface, the sporangia attached to the sides of the ridge, the reflexed edge of the lamina protecting them. *Sporangia* not quite symmetrically ovoid or ellipsoid, sessile, with distal annulus of a single row of cells; spores pale, monolete, the surface variously sculptured.

**D i s t r.** Pantropic, comprising c. 30 *spp.*, widely distributed also in temperate regions of the southern hemisphere (S. Africa, Chile, New Zealand, Tasmania) but only in N. America in the northern hemisphere.

**Morph.** PRANTL referred to the whole fertile apex of a frond of *Schizaea* (or of a branch of *S. dichotoma*) as a sorophore; he called the lateral appendages *laciniae*. But it seems probable that each lacinia is homologous with a sorophore of *Lygodium*, and the term sorophore is therefore here used for what PRANTL called a lacinia. Photosynthetic tissue in *Schizaea* is reduced to the wings on each side of the axis of a simple frond, or of the branches of *S. dichotoma*. The regular row of stomata associated with this photosynthetic tissue (a double row in *S. inopinata*) corresponds to a similar less regular row along each side of the stipe and rachis of many ferns. In *Lygodium*, there are irregularly scattered stomata on both sides of the narrow rachis-wings.

**Spores.** SELLING published a very full account of the spores of all species known to him in 1944 (Medd. Göteb. Bot. Trädg. 16, 1-112, p. 1-5). He also discussed the later-known species of the group of *S. digitata* (Svensk Bot. Tidskr. 41, 1947, 431-450). Fossil spores are also known (see remarks on fossils, *supra*).

#### KEY TO THE SPECIES

1. Fronds repeatedly dichotomous . . . . . 1. *S. dichotoma*
1. Fronds simple.
  2. Sorophores 2½-5 cm long, all attached close together at apex of frond; frond 2 mm or more wide.
    3. Sporangia in four rows on the sorophores; one row of stomata on each wing of the frond. 2. *S. digitata*
    3. Sporangia in two rows on sorophores; stomata in two rows on each wing of the frond. 3. *S. inopinata*
  2. Sorophores much shorter, fronds narrower.
    4. Edges of sorophores smooth and glabrous.
      5. Fronds more than 1 mm wide, with distinct flat wing on each side of costa; no hairs with sporangia.
        6. Costa very prominent on lower surface; stomata in each row very close together 2. *S. digitata*
        6. Costa hardly prominent on lower surface; stomata in each row rather widely spaced. 4. *S. spirophylla*
      5. Fronds less than 1 mm wide, wing very slightly developed; hairs present with sporangia. 5. *S. wagneri*
    4. Edges of sorophores irregularly lobed, the lobes bearing coarse hairs.
      7. Sorophores attached along the distal 10-20 mm of the axis of the frond; upper surface of frond deeply grooved, lower surface evenly rounded and bearing superficial rows of stomata. 6. *S. fistulosa*
      7. Sorophores attached along the distal 5-10 mm of the axis of the frond; upper surface of frond slightly grooved, stomata in two slight grooves on the distinctly flattened lower surface 7. *S. malaccana*

1. *Schizaea dichotoma* (L.) SM. Mem. Ac. Turin 5 (1793) 422, t. 9; BL. En. Pl. Jav. (1828) 255; HOOK. & GREV. Ic. Fil. (1827) t. 17; BEDD. Ferns S. India (1863) t. 65; Handb. (1883) 452; PRANTL, Unters. Morph. Gefässkr. 2 (1881) 138; RACIB. Pterid. Buit. (1898) 6; v. A. v. R. Mal.



Fig. 2. *Schizaea dichotoma* (L.) SM. near Kepahiang, Bencoolen, S. Sumatra (DE VOGD).

Ferns (1908) 116; MERR. Int. Rumph. (1917) 69; BACKER & POSTH. Varenfl. Java (1939) 256, fig. 66; HOLTT. Ferns Mal. (1955) 50, fig. 6.—*Acrostichum dichotomum* LINNÉ, Sp. Pl. (1753) 1068.—*Osmunda dichotoma* SPR. in Schrader, J. Bot. (1799) pt 2, 268.—*Ripidium dichotomum* BERNH. in Schrader, J. Bot. 1800, pt 2 (1801) 127, t. 2, f. 3.—*S. forsteri* SPR. Anleit. 3 (1804) 57.—*S. cristata* WILLD. Sp. Pl. 5 (1810) 88.—*S. biroi* RICHTER, Math. Termeszet. Ertesito 29 (1911)

1074; TROLL, Flora 128 (1933) 339, fig. 1.—*S. copelandica* RICHTER, l.c.—Fig. 1, 2, 4a-d.

Rhizome 3–6 cm below surface of ground, creeping, sometimes to 6 cm or more long, densely covered with coarse shining brown hairs 2–3 mm long. Stipes commonly 15–30 cm long (extremes 10–50 cm), narrowly winged towards apex; frond commonly 10–20 cm long and wide, dichotomously branched 2–8 times, the basal branches like the stipe, the distal ones gradually with wider wings and 1–1½ mm wide, lacking a prominent costa on the lower surface; all parts with scattered small projections which are the bases of glandular hairs; sorophores occupying the distal 3–5 mm of each branch of the frond, 5–10 pairs, the lowest 3–4 mm long, upper ones smaller, edges hairy; sporangia in two rows, mixed with conspicuous long brown hairs; spores smooth or minutely granular.

Type: Petiver, Gaz. t. 70, f. 12 (drawing of a specimen from Cochinchina).

Distr. Mascarene Isl., Ceylon and S. India, Burma, Siam, Indochina, throughout Malaysia except for East Java and Lesser Sunda Isl., to Tahiti, Australia, and New Zealand.

Ecol. In lightly shaded places, or sometimes in forest, often (always?) in sandy ground, sealevel to 1000 m, rarely abundant.

Note. Small plants like those named *S. biroi* and *S. copelandica* by RICHTER are not uncommon, and have been found at many places near larger plants. As pointed out by TROLL (l.c.) the small little-branched fronds of these small plants are usually fertile, whereas some fronds of much larger plants are sometimes sterile. I have however examined a very large number of specimens and have failed to find any sharp distinction between those with little-branched and much-branched fronds. If one picks out individual specimens, one can separate fronds with long and with short ultimate branches; but in some cases fronds from one collection may show ultimate branches of very diverse length.

Vern. *Tatagar payong*, Kedayan, *pirangas*, Murut, *oemiar*, *biak*, E. New Guinea, *paku tjakar ajam*, *radja hantu*, Banka, *rumpul bulu merak*, Billiton, *silaju*, Sum.

Uses. HEYNE records medicinal use (in Billiton) for coughs and affections of the throat and also in childbirth.

2. *Schizaea digitata* (L.) Sw. Syn. Fil. (1806) 150, 380, t. 4 f. 1; BL. En. Pl. Jav. (1828) 255; BEDD. Ferns S. India (1864) t. 268; Handb. (1883) 452; PRANTL, Unters. Morph. Gefässkr. 2 (1881) 133, t. 5 f. 83; CLARKE, Trans. Linn. Soc. Bot. 1 (1880) 583; RACIB. Pterid. Buit. (1898) 7; v. A. v. R. Mal. Ferns (1908) 116; BACKER & POSTH. Varenfl. Java (1939) 257, f. 66; SELLING, Svensk. Bot. Tidskr. 41 (1947) 431–450; HOLTT. Ferns Mal. (1955) 51, f. 7.—*Acrostichum digitatum* LINNÉ, Sp. Pl. (1753) 1068.—*Actinostachys digitata* WALL. ex REED, Bol. Soc. Brot. 21 (1947) 130.—Fig. 3a-e.

Rhizome very short, creeping or suberect, 3–4 cm below surface of ground, bearing many crowded fronds, apex clothed with brown hairs under 2 mm long. *Fronds* erect, unbranched, grass-like, 20–35 cm long, base (stipe) slender and triquetrous, rest winged, greatest width 2–4 mm,

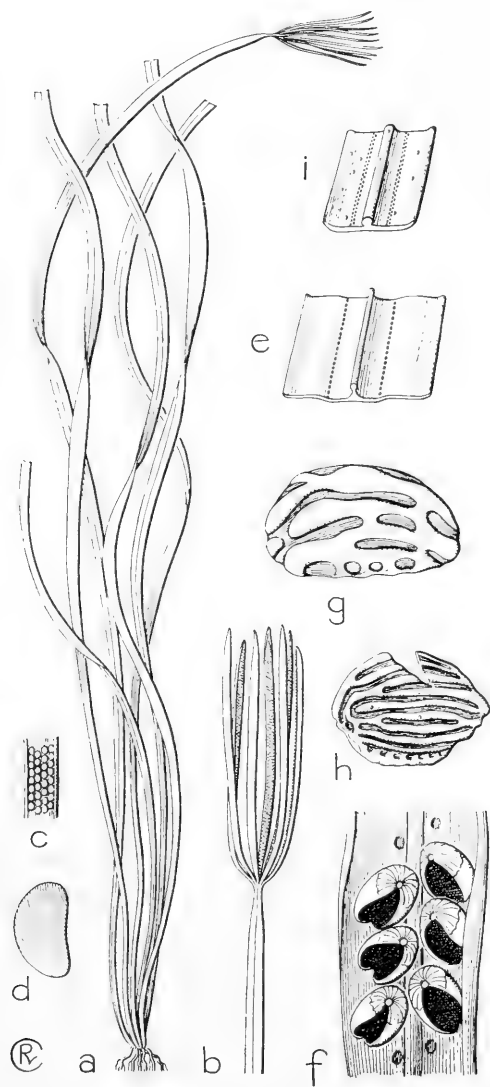


Fig. 3. *Schizaea digitata* (L.) Sw. a. Habit,  $\times \frac{1}{2}$ , b. sorophores, nat. size, c. detail of sorophore,  $\times 5$ , d. spore,  $\times 300$ , e. detail of lower surface showing stomata,  $\times 5$ .—*S. inopinata* SELLING. f. Detail of sorophore,  $\times 18$ , g. spore,  $\times 300$ , h. flattened part of exospore,  $\times 200$ , i. lower surface of leaf, showing stomata,  $\times 5$  (a, e For. Bot. Burma 7670, b–c MATTHEW s.n. (SING), f SYNGE S606, g SYMINGTON CF 37414, h after SELLING 1946).

costa very prominent on lower surface of winged portion and slightly grooved on upper surface, 2-celled glandular hairs abundant on lower surface of wing, stomata in a close even single row on each side of costa. *Sorophores* all attached very close together (apparently digitate), 5–18, all about equal in length, commonly  $2\frac{1}{2}$ –5 cm long (on stunted plants sometimes shorter), little over 1 mm wide, edges thin, entire, glabrous; *sporangia* small, apparently in four rows and completely covering lower surface of sorophore; spores small, finely and evenly obliquely striate.

Type: Herb. Hermann, Ceylon (BM).

Distr. Ceylon, NE. India, Siam, Indochina, Micronesia; in *Malaysia*: throughout except for East Java and Lesser Sunda Isl.

Ecol. In lightly shaded forest, rubber estates, etc., sealevel to 1200 m, rarely very abundant.

Notes. The species was formerly credited with a much wider distribution, due to confusion with other species. SELLING has distinguished most of the latter, and has given a comparative survey of the group and of individual distributions (*l.c.*). *Actinostachys boninensis* NAKAI (J. Jap. Bot. 13, 1937, 140) appears to differ from *S. digitata* only in the greater number of sorophores (to 30) which are shorter (8–40 mm long); I have seen no specimens.

3. *Schizaea inopinata* SELLING, Svensk Bot. Tidskr. 40 (1946) 274, f. 1–7; HOLTT. Ferns Mal. (1955) 52.—*Actinostachys inopinata* REED, Bol. Soc. Brot. 21 (1947) 130.—Fig. 3f–i.

In habit like *S. digitata*, differing as follows: *fronds* to  $2\frac{1}{2}$  mm wide, with a double (occasionally triple) row of stomata on each side of the costa on the lower surface, the wings thicker and more rigid and the edges reflexed on drying, the costa not so strongly raised and rather variable; *sporangia* much larger, in two rows; spores much larger, with broad irregular longitudinal ridges.

Type: Henderson 19460, Gua Tipus, Chigar Perah, Pahang (SING, K).

Distr. Micronesia, in *Malaysia*: Sumatra, Malaya, Borneo, Philippines (Bohol), W. New Guinea.

Ecol. On limestone crags, sealevel to 300 m.

Note. FOSBERG, correctly reporting the occurrence of the species in Micronesia, considered it conspecific with *S. ponapensis* HOSOKAWA (Am. Fern J. 40, 1950, 145). I have examined the isotype of *S. ponapensis* in the Arnold Arboretum Herbarium, and find that, apart from its much smaller size (fronds to 8 cm long, sorophores to 8 mm long) it differs in having a hardly raised costa with a rather widely-spaced single row of stomata on each side of it. The specimen corresponds well with the description of *S. spirophylla* TROLL, and I have placed *S. ponapensis* as a synonym of that species. I saw no spores.

4. *Schizaea spirophylla* TROLL, Flora 128 (1937) 343, fig. 2–6.—*S. ponapensis* HOSOKAWA, Trans. Nat. Hist. Soc. Formosa 31 (1941) 39.

Rhizome short, apex covered with dark hairs. *Fronds* unbranched, sometimes twisted, 4–8 cm

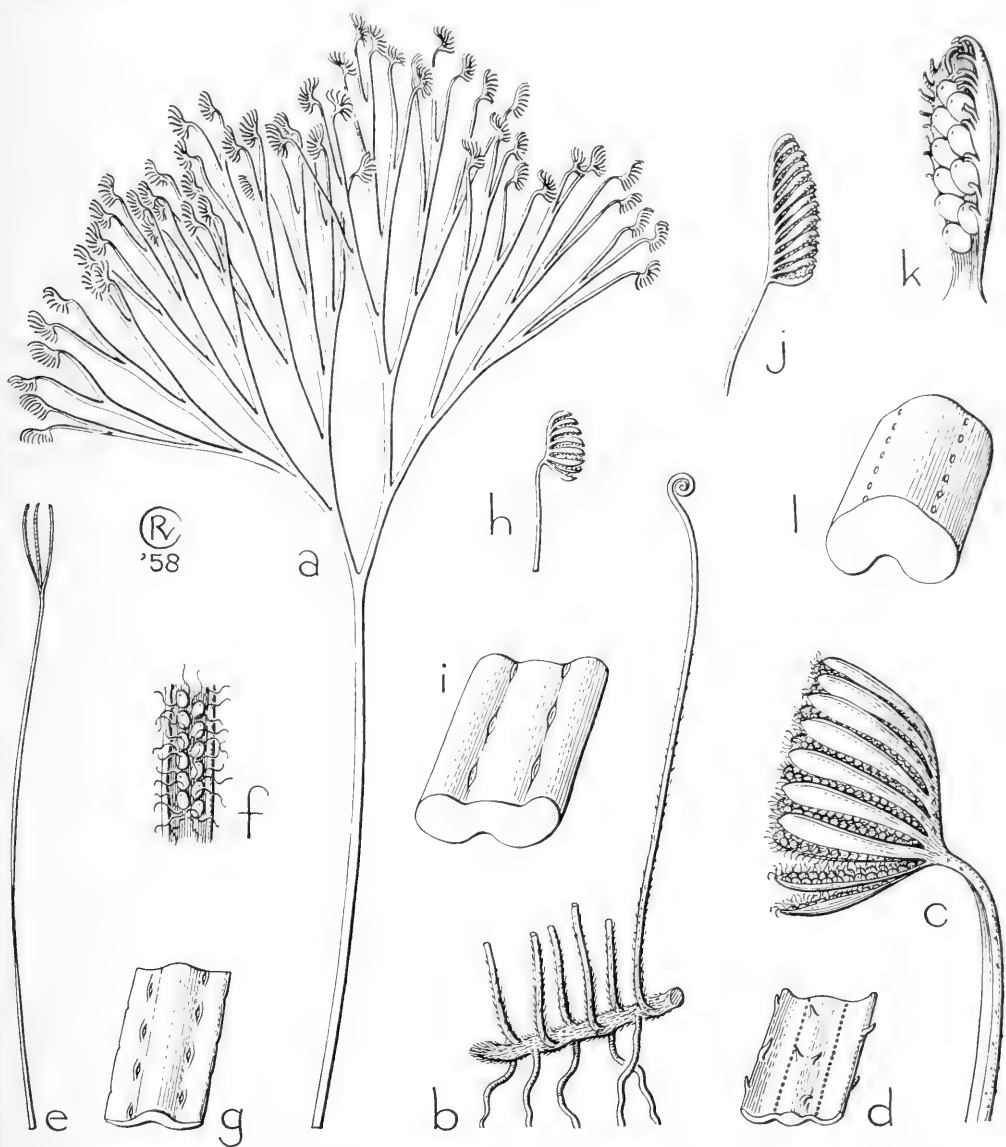


Fig. 4. *Schizaea dichotoma* (L.) SM. *a.* Habit,  $\times \frac{2}{3}$ , *b.* rhizome,  $\times \frac{2}{3}$ , *c.* soriophores,  $\times 7$ , *d.* lower surface of leaf,  $\times 14$ .—*S. wagneri* SELLING. *e.* Habit,  $\times \frac{4}{3}$ , *f.* detail of soriophore,  $\times 14$ , *g.* lower surface of leaf,  $\times 27$ .—*S. malaccana* BAKER. *h.* Soriophores,  $\times \frac{4}{3}$ , *i.* lower surface of leaf showing stomata,  $\times 27$ .—*S. fistulosa* LABILL. *j.* Soriophores,  $\times \frac{4}{3}$ , *k.* detail of soriophore,  $\times 7$ , *l.* lower surface of leaf, showing stomata,  $\times 27$  (*a* HOSE 199, *b* BRASS 8583, *c-d* FMS 199, *e-g* GREYER & WAGNER 4177, *h-i* SFN 1100, *j-l* CLEMENS 10729).

long, about  $1\frac{1}{2}$  mm wide, costa very slightly prominent on the lower surface, with a distinct flat wing on each side of it; stomata in one row on each side of the costa, rather widely spaced in the rows; soriophores 1–3, 4–8 mm long (sometimes longer?), glabrous, the sporangia in two

rows (sometimes apparently in 4 rows near the middle); spores as in *S. digitata*.

Type: Troll, Ambon (M).

Distr. Micronesia (Ponape); in Malaysia: Moluccas (Ambon).

Ecol. Growing in moss-cushions on trees.

Note. See note under *S. inopinata*. The twisting of the fronds of *S. spirophylla* is probably not a constant character; such twisting is also common, but not universal, in *S. digitata*. Stunted plants of the latter may superficially resemble *S. spirophylla* but differ in costa and stomata and in more crowded sporangia.

**5. *Schizaea wagneri*** SELLING, Svensk Bot. Tidskr. 40 (1946) 278, f. 8–11; HOLTT. Ferns Mal. (1955) 52.—*Actinostachys wagneri* REED, Bol. Soc. Brot. 21 (1947) 131.—*S. paucijuga* HOLTT. Gard. Bull. Sing. 11 (1947) 267.—**Fig. 4e–g.**

Rhizome short, apex clothed with slender brown hairs  $1\frac{1}{2}$  mm long. *Fronds* simple, 6–20 cm long, base terete, upper part winged and in all  $\frac{1}{2}$ – $\frac{3}{4}$  mm wide, with rather broad midrib prominent on the lower surface, the stomata rather widely spaced in one row close to each side of the midrib. *Sorophores* 2–5, 7–15 mm long, edges smooth and glabrous, *sporangia* in two rows, mixed with brown hairs; spores finely verrucose.

Type: Grether & Wagner 4177, summit of Mt Tjajiak, 600 m, Manus Isl., Admiralty Is. (S-PA, dupl. at K).

Distr. *Malaysia*: Malaya (P. Rumbia in Perak, Singapore) Borneo, Ambon, W. New Guinea, and Admiralty Is.

Ecol. "Epiphytic in mosses on stumps and bases of trees; abundant at one place, but exceedingly inconspicuous" (GRETHER & WAGNER). In forest near sea (Western New Guinea and Borneo).

**6. *Schizaea fistulosa*** LABILL. Nov. Holl. Pl. Spec. 2 (1806) 103, t. 250 f. 3; PRANTL, Unters. Morph. Gefässkr. 2 (1881) 135, *excl. var. malaccana* and *var. robusta*; V. A. v. R. Mal. Ferns (1908) 116; C. CHR. & HOLTT. Gard. Bull. S. 7 (1934) 210.—*Microschizaea fistulosa* REED, Bol. Soc. Brot. 21 (1947) 134.—*S. propinqua* A. CUNN. in Hook. Comp. Bot. Mag. 2 (1836) 362.—*S. australis* GAUD. Ann. Sc. Nat. Bot. 5 (1825) 98.—*S. chilensis* PHIL. Linnaea 30 (1859–60) 207.—**Fig. 4j–l.**

Rhizome short-creeping, young parts clothed with shining brown hairs 2–3 mm long; stipes very crowded; *fronds* unbranched, 9–18 (rarely to 30) cm long below the fertile part, width to about 1 mm, upper surface rather deeply grooved, lower surface almost evenly rounded and bearing two rows of stomata which are not in grooves; surfaces bearing scattered glandular hairs the bases of which are slightly prominent. *Sorophores* all about equal, arranged in a distinctly pinnate manner

along the distal 10–20 mm of the axis of the frond, 8–20 pairs, lowest often forked, 4–6 mm long, edges much reflexed and bearing many coarse forward-pointing hairs; *sporangia* in two rows, without hairs; spores smooth.

Type: Labillardière, Australia (F?; not seen).

Distr. Madagascar, Australia, Tasmania, New Zealand, Fiji, New Caledonia, Chile; in *Malaysia*: Borneo (Mt Kinabalu), New Guinea.

Ecol. In alpine bogs at 2400–3750 m, and on fine rock-screes.

Note. Some New Guinea specimens have been distributed as *S. papuana* BRAUSE, which is here placed as a synonym of *S. malaccana*.

**7. *Schizaea malaccana*** BAK. Syn. Fil. (1868) 428; BEDDOME, Ferns Br. India (1870) t. 255; Handb. (1883) 452; TANSLEY & CHICK, Ann. Bot. 17 (1903) 493–510; V. A. v. R. Mal. Ferns (1908) 116; HOLTT. Ferns Mal. (1955) 52, fig. 8.—*S. fistulosa* var. *malaccana* PRANTL, Unters. Morph. Gefässkr. 2 (1881) 136.—*S. papuana* BRAUSE, Bot. Jahrb. 56 (1920) 211.—*Microschizaea malaccana* REED, Bol. Soc. Brot. 21 (1947) 134.—**Fig. 4h–i.**

var. *malaccana*.

Habit of *S. fistulosa*, differing as follows: hairs on rhizome pale brown, *fronds* 6–15 cm long, less than 1 mm wide, apical fertile part of axis c. 5 mm long, upper surface of frond nearly flat or shallowly grooved, lower surface when dry with two small grooves in which the stomata are situated; *sorophores* 4–10 pairs, lowest 4–5 mm long, upper ones shorter.

Type: Cuming 379, Mt Ophir, Malaya (K, BM).

Distr. *Malaysia*: Malaya, Borneo, Ambon, W. New Guinea.

Ecol. In open mossy places on mountain ridges, or in moss cushions on trees at 800–2000 m; also in swamp forest in Sarawak at lower altitudes.

var. *robustior* C. CHR. Gard. Bull. S.S. 7 (1934) 210.—*S. hallieri* RICHTER, Med. Rijksherb. n. 28 (1916) 24, t. 1 f. 5, etc.; Math. Naturw. Ber. Ungarn 31 (1916) 24, 28, t. 1 f. 5 etc.—*Microschizaea hallieri* REED, Bol. Soc. Brot. 21 (1947) 134.

Larger than var. *malaccana*; *fronds* to 25 cm long, 1 mm or more wide; *sorophores* to 15 pairs, spread along 10 mm of the axis, lowest *sorophores* 5–10 mm long.

Type: Clemens 10919, Mt Kinabalu, Borneo (BM, Bo).

Distr. *Malaysia*: Malaya (Gunong Tahan), Borneo, W. New Guinea.

## 2. LYGODIUM

SWARTZ in Schrader, J. Bot. 1800 pt 2 (Nov.–Dec. 1801) 106, *nom. cons.*; PRANTL, Unters. Morph. Gefässkr. 2 (1881) 60; COPELAND, Gen. Fil. (1947) 23; PICHISERMOLLI, Webbia 12 (1956) 10, preprint (1955).—*Ramondia* MIRBEL, Bull. Soc. Philom. Paris 2 (Feb.–Mar. 1801) 179.—*Ugena* CAVAN. Ic. Descr. Pl. 6 (Oct. 1801) 73.—*Odontopteris* BERNH. in Schrader, J. Bot. 1800 pt 2 (Nov.–Dec. 1801) 127, t. 2 f. 4.—*Ripidium* BERNH. l.c. 127, t. 2 f. 3.—*Gisopteris* BERNH. l.c. 129,

t. 2 f. 1.—*Hydroglossum* WILLD. Abh. Kurfürstl. Mainz. Ak. Nützl. Wiss. Erfurt 2, pt 4 (1802) 13, 20.—*Hugona* CAV. ex ROEMER, Arch. Bot. 2 (1801–02) 486.—*Cteisium* MICHX, Fl. Bor. Am. 2 (1803) 275.—*Vallifilix* THOUARS, Gen. Nov. Madag. (1808) 1.—*Lygodictyon* J. SMITH in Hook. Gen. Fil. (1842) t. 111 B.—**Fig. 5–15.**

Rhizome creeping, below ground surface, protostelic, short with fronds very close together or longer with spaced fronds, young parts densely covered with rather thick rigid multiseptate hairs, branching dichotomous; fronds borne in two rows on upper surface of rhizome, roots mainly from lower surface. *Fronds* of young plants erect, once or twice dichotomously branched and bearing usually palmately lobed leaflets; fronds of older plants with slender elongate twining rachises formed by a succession of very unequal dichotomies, at least the upper part of the rachis (except in *L. polystachyum*) bearing two narrow wings towards the adaxial side, the surface between the wings flat or slightly raised and papillose; all branch rachises and stalks of leaflets similarly winged (fig. 13d), the wings always interrupted to join with those of a lateral branch; *primary rachis-branches* always short, usually hardly developed, ending in dormant apices which are covered with hairs (such apices proliferous if the main rachis beyond them is injured), each primary branch bearing a pair of secondary branches which bear the leaflets; sterile *leaflets* (or their lobes) with costa and oblique lateral veins which are 1–3 times forked (anastomosing in a few species), edges entire or serrate (pinnatifid only in *L. polystachyum*); fertile leaflets often with contracted lamina, bearing narrow *sorophores* spreading from the edges of the lamina at the ends of most of the veins; edges of sorophores serrate, the main vein in each sorophore bearing alternate short lateral veins each of which bears a single sporangium protected by a separate indusium attached along the vein and opening forwards; *sporangia* oblong-ovoid with a short lateral stalk, the annulus at the narrower end which is directed away from the margin of the sorophore, splitting longitudinally when ripe; *spores* trilete, pale, variously sculptured on the surface, lacking perispore. *Gametophyte* thalloid, sometimes asymmetric; antheridia larger and more complex in structure than in most leptosporangiate ferns.

Distr. Pantropic, comprising c. 40 spp., also extratropical southwards in New Zealand and S. Africa, northwards in Japan and in eastern U.S.A. to Massachusetts.

Morph. Owing to the peculiar structure of the climbing leaves, it is difficult to apply the usual descriptive terms pinna and pinnule to them, especially where the branching of the leafy parts is dichotomous. The following terms are here used. The *climbing rachis* of the frond (sympodial in structure but for convenience considered as a unit) bears alternate short *primary branches*, each ending in a dormant apex and bearing a pair of apparently opposite *secondary branches*. The secondary branches may bear leaflets or *tertiary branches* pinnately arranged, or they may be once or more times dichotomously branched.

The narrow wings on rachis-branches of all orders, those of the ultimate branches joined to the edge of the lamina, correspond with the wings which are the only lamina in fronds of *Schizaea*, but do not have the very regular single rows of stomata found in *Schizaea* (there are irregularly scattered stomata on both sides of a wing in *Lygodium*). If the sorophores of *Lygodium* are regarded as homologous with the fertile leaflet-lobes of the paleozoic fossil genus *Senftenbergia*, the lamina of *Lygodium* may be considered as a specialized development of the rachis-wing consequent on the reduction of the original lamina-lobes to sorophores.

The dormant apices of the primary rachis-branches are covered with septate hairs. In a group of Malaysian species these hairs have swollen bases, each base formed of a mass of cells; these species are *L. borneense*, *L. longifolium*, *L. auriculatum*, *L. trifurcatum*, and *L. dimorphum*. So far as I know, this type of hair has not hitherto been reported in *Lygodium*.

Taxon. There are four pairs of species which in some measure intergrade. These need experimental study in cultivation to discover how much variation is due to environmental conditions, and also cyto-



logical study. It may be that natural hybridization occurs, and as tetraploids as well as diploids have been already discovered in *L. japonicum* and *L. circinnatum* they may occur also in other species, leading to the possibility of the formation of sterile triploids; apogamy has however not yet been discovered in the genus. The pairs of species which intergrade are: *L. flexuosum* and *L. japonicum*; *L. flexuosum* and *L. salicifolium*; *L. borneense* and *L. auriculatum*; *L. dimorphum* and *L. trifurcatum*. The following species are very distinct: *L. polystachyum*, *L. microphyllum*, *L. circinnatum*, *L. merrillii*, and *L. versteegii*.

## KEY TO THE SPECIES

1. Secondary rachis-branches pinnate, leaflets 10–15 on each side. Sterile leaflets evenly pinnatifid throughout . . . . . **1. *L. polystachyum***
1. Secondary rachis-branches pinnate with fewer leaflets, or dichotomous. Sterile leaflets simple, palmate, or lobed near the base only.
2. Venation of sterile leaflets free.
3. Primary rachis-branches 4–10 mm long below the pair of secondary branches. Rhizome wide-creeping, fronds distinctly spaced.
4. Secondary branches simply pinnate. Leaflets articulate at the base and ultimately deciduous. . . . . **2. *L. microphyllum***
4. Secondary branches amply bipinnate. Leaflets not articulate at the base . . . . . **3. *L. japonicum***
3. Primary rachis-branches hardly elongated, the pair of secondary branches thus almost sessile on the main rachis. Rhizome short, fronds close together.
5. Secondary rachis-branches regularly pinnate, normally with 3–5 leaflets on each side of the axis (young or depauperate fronds may have fewer leaflets).
6. Leaflets all about equal and all stalked (terminal one sometimes geminate), not auricled or branched at the base, or rarely with short spreading basal lobes; leaflet-stalks thickened at their junction with the lamina . . . . . **4. *L. salicifolium***
6. Lateral leaflets larger towards base of secondary branch, smaller distal ones sessile, basal ones stalked and usually auricled or with obliquely spreading lobes, or with subsidiary leaflets below them; leaflet-stalks not thickened at apex . . . . . **5. *L. flexuosum***
5. Secondary branches simple or dichotomously branched one or more times (in some cases, by alternate unequal dichotomy, subpinnate with 1–3 lateral leaflets). Leaflets simple, forked, or palmately branched, never thickened at apex of stalk.
7. Leaflets strongly cordate on outer side at base.
8. Lamina of fertile leaflets reduced to a narrow wing along midrib and bases of veins, each vein usually with an apical sorophore.
9. Fertile tertiary branches evenly deltoid in outline with quaternary leaflets of increasing length towards the base. Sterile leaflets strongly auriculate-cordate at base . . . . . **6. *L. dimorphum***
9. Fertile leaflets not deltoid in outline, 10–15 mm wide (including sorophores), sometimes with 1 or 2 long branches at the base. Sterile leaflets more or less cordate at the base. . . . . **7. *L. trifurcatum***
8. Lamina of fertile leaflets not reduced to a narrow wing along midrib and veins. . . . . **8. *L. auriculatum***
7. Leaflets not strongly cordate at base on outer side.
10. Secondary branches once forked (rarely simple, or one branch forked again). Leaflets always simple. Spores smooth . . . . . **9. *L. borneense***
10. Secondary branches at least twice forked (or lower branches bearing single 3–5-lobed leaflets), sometimes sub-pinnate with 1–2 tertiary members on each side and a terminal leaflet or pair of leaflets. Leaflets often deeply 2-lobed to palmate. Spores verrucose.
11. Margins of sterile leaflets serrate, not much thickened, veins ending in the teeth. Spores coarsely and irregularly verrucose. Dormant apices of primary branches not sunk, hairs with swollen base . . . . . **10. *L. longifolium***
11. Margins of sterile leaflets entire, thickened but not vascular, the raised veins joining the thickened edge. Spores finely and evenly verrucose. Dormant apices sunk, hairs lacking swollen bases . . . . . **11. *L. circinnatum***
2. Venation of sterile leaflets reticulate.
12. Secondary rachis-branches (at least the upper ones) elongate and pinnate.
13. Leaflets on stalks to 3 cm long, palmately lobed or equally bilobed (basal secondary branches may bear only one palmately lobed leaflet on a longer stalk) . . . . . **12. *L. merrillii***
13. Leaflets on much shorter stalks, simple or the apical ones forked . . . . . **14. *L. reticulatum***
12. Secondary branches bearing 3 leaflets (lateral ones sometimes forked), all arising 1–3 mm from dormant apex of primary rachis-branch . . . . . **13. *L. versteegii***

**1. *Lygodium polystachyum* WALL. ex MOORE**, Gard. Chron. (1859) 671; HOOK. Sec. Cent. (1861) t. 76; Syn. Fil. (1868) 438; BEDDOME, Ferns Br. India (1868) t. 300; Handb. (1883) 458, f. 284;

v. A. v. R. Mal. Ferns (1908) 113; COPEL. Philip. J. Sc. Bot. 4 (1909) 19; TARD. & C. CHR. Fl. Gén. I.–C. 7 (1939) 40; HOLTT. Ferns Mal. (1955) 56, f. 10; ALSTON & HOLTT. Reinwardtia 5 (1959)



11. — *Hydroglossum pinnatifidum* WILLD. Abh. Kurf. Mainz. Ak. Wiss. Erfurt 2, pt 4 (1802) 21, p.p.—*L. pinnatifidum* (non (WILLD.) SW.) PRANTL, Unters. Morph. Gefässkr. 2 (1881) 83, t. 1 f. 11.—Fig. 5c, 8a-c.

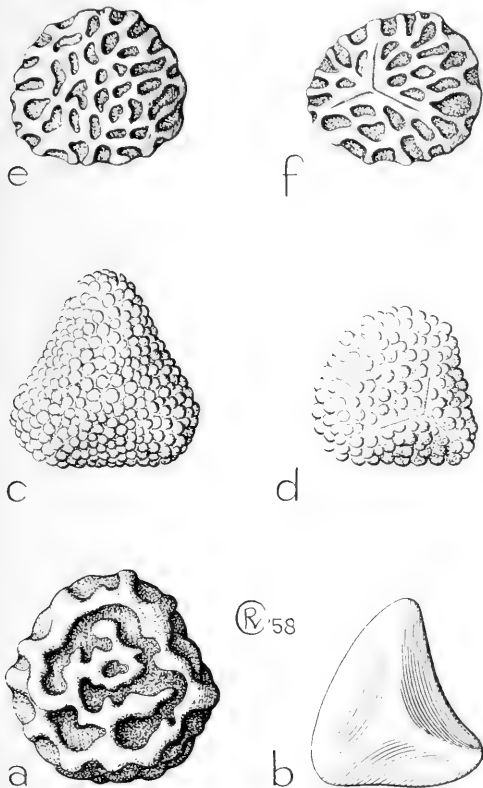


Fig. 5. Spores of *Lygodium*. a. *L. longifolium* (WILLD.) SW., b. *L. borneense* v. A. v. R., c. *L. polystachyum* WALL. ex MOORE, d. *L. circinnatum* (BURM. f.) SW., e-f. *L. microphyllum* (CAV.) R. BR., lateral and upper view. All  $\times 330$ .

Rhizome short-creeping, 3–5 mm diameter, densely clothed with spreading black hairs. Juvenile fronds once or twice dichotomous; stipes up to 30 cm long to the first dichotomy, brown, with short very slender hairs mixed with thick longer multicellular ones; ultimate branches leafy like the secondary rachis-branches of climbing fronds. *Rachis* of climbing fronds 2½ mm diameter, shortly hairy, not winged; primary rachis-branches very short, ending in a dormant apex covered with brown hairs (the apices of lower primary branches sometimes proliferous); secondary rachis-branches 20–30 cm long, not winged, shortly hairy, bearing 10–15 leaflets on each side and a similar terminal leaflet; sterile leaflets 3½–7½ cm long, 1½–2 cm wide, apex rather abruptly narrowed and rounded, base truncate or

cordate, jointed to a hairy stalk 1–4 mm long, sides lobed half-way to the costa or rather more, lobes 4–5 mm wide, oblong with rounded apex, each lobe with a sinuous costule bearing oblique forked lateral veins, costa and costules bearing scattered stiff hairs on both surfaces, the costa also with shorter hairs; fertile leaflets like the sterile but the distal half or more of each lobe narrowed to about 2 mm wide, the narrow part (sorophore) 4–10 mm long, bearing sporangia on the under surface; indusia bearing scattered stiff hairs; spores finely and evenly verrucose.

Type: Wallich 177, Penang (K).

Distr. Assam, Burma, Siam, Yunnan, Indochina; in *Malaysia*: northern half of Malay Peninsula.

Ecol. In lowland forest, climbing trees to a considerable height; in the Malay Peninsula especially on limestone except in the extreme north (Kedah) where it is locally common apparently primary forest. (Further south limestone provides a drier habitat than old rocks, and on it occur a number of species which have their main distribution in the seasonal climate north of Malaya.)

2. *Lygodium microphyllum* (CAV.) R. BR. Prod. Fl. Nov. Holl. (1810) 162; BL. En. Pl. Jav. (1828) 253; CLARKE, Trans. Linn. Soc. Bot. 1 (1880) 583; BEDD. Handb. (1883) 455, t. 282; ALSTON & HOLTT. Reinwardtia 5 (1959) 12.—*Ugena microphylla* CAV. Ic. Descr. Pl. 6 (1801) 76, t. 595; C. CHR. Dansk Bot. Ark. 9, n. 3 (1937) 30.—*L. scandens* SW. in Schrader, J. Bot. 1800 pt 2 (1801) 106, p.p. excl. syn. LINN.; BEDD. Ferns S. India (1863) t. 61; HOOK. Syn. Fil. (1868) 437, p.p.; PRANTL, Unters. Morph. Gefässkr. 2 (1881) 81, t. 6 f. 101; CHRIST, Farnkr. Erde (1897) 354, f. 1116; RACIB. Pterid. Buit. (1898) 8; v. A. v. R. Mal. Ferns (1908) 113; Philip. J. Sc. 11 (1916) Bot. 116; HEYNE, Nutt. Pl. (1927) 97; BACK. Krakatoa (1929) 254; OCHSE & BAKH. Veg. D.E.I. (1931) 657; BURK. Dict. 2 (1935) 1378; BACKER & POSTH. Varenfl. Java (1939) 258; OGATA, Ic. Fil. Jap. 7 (1936) t. 324; HOLTT. Ferns Mal. (1955) 58, f. 12.—*Ophioglossum filiforme* ROXB. Calc. J. Nat. Hist. 4 (1844) 476, t. 26 f. 3.—*L. scandens* var. *microphyllum* (CAV.) LUERSS. J. Mus. Godeffr. 6 (1874) 4.—*L. scandens* var. *intermedium* CES. Att. Ac. Sc. Fis. Nat. Napoli 7 (1876) 33.—Fig. 5e-f, 6, 7.

Rhizome wide-creeping, dichotomously branched, 2½ mm diameter, densely clothed with short spreading brownish-black hairs. Juvenile fronds small, commonly once dichotomous (the stipe distinctly winged below the dichotomy), each branch bearing a 4-lobed leaflet not jointed at the base, lobes 3–5 cm long and c. 5 mm wide, thin, glabrous, edges crenately toothed (teeth larger towards apex where veins are unbranched). *Rachis* of climbing fronds glabrous, commonly 2–3 m long, hardly 1½ mm diameter; primary branches 4 mm or more long, ending in a dormant apex covered with dark brown hairs; secondary rachis-branches pinnate, in all to about 15 cm



Fig. 6. *Lygodium microphyllum* (CAV.) R. BR. and *L. salicifolium* PR. (larger leaflets on left) on edge of a thicket in the Botanic Gardens, Singapore (HOLTUM).

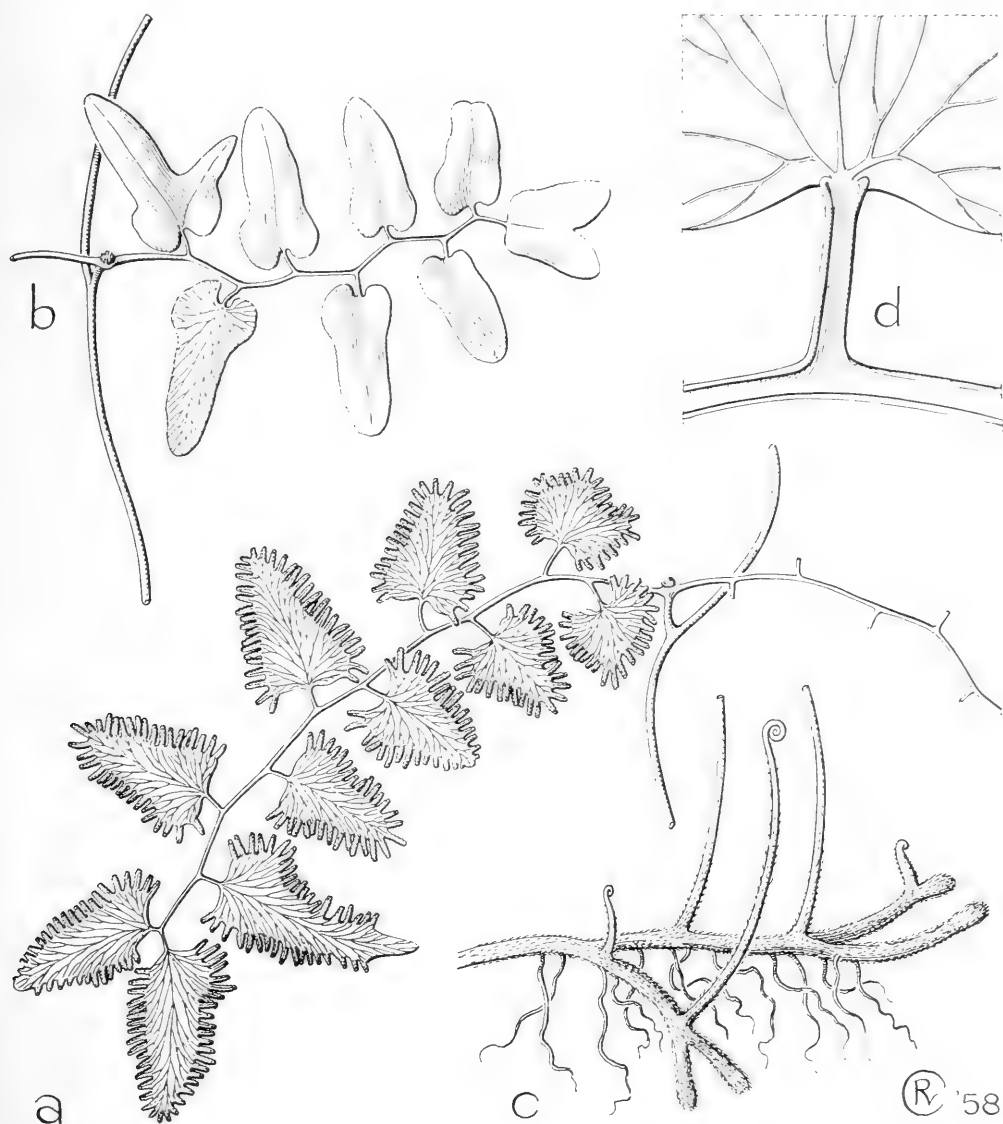


Fig. 7. *Lygodium microphyllum* (Cav.) R. Br. a. Fertile leaf,  $\times \frac{3}{4}$ , b. sterile leaf,  $\times \frac{3}{4}$ , c. rhizome,  $\times \frac{3}{4}$ , d. detail of base of leaflet,  $\times 7$  (a FLOYD NGF 5566, b-d cult. Kew from Ceylon).

long, with 3-6 stalked leaflets on each side (stalks 2-4 mm long) and a similar or geminate terminal leaflet; leaflets quite glabrous, mostly ovate (sterile leaflets often elongate with broader base on young plants), 1-4 cm long (sterile ones sometimes to 6 cm), 6-18 mm wide, edges of sterile ones minutely crenate, a joint always present at base of blade, where the wing which in other species connects stalk and lamina is constricted; fertile leaflets usually shorter than

sterile but with lamina hardly narrowed, soriophores 4-6 mm long; spores with a raised reticulum on the outer surface.

Type: Née, Luzon (MA).

Distr. Tropical Africa, SE. Asia (north to Bengal and Hong Kong and the Riu Kiu Isl.), Melanesia (Solomon Isl., New Caledonia), N. and E. Australia south to N. S. Wales; in Malaysia: throughout, but few records from the Lesser Sunda Isl. (certainly to Flores).

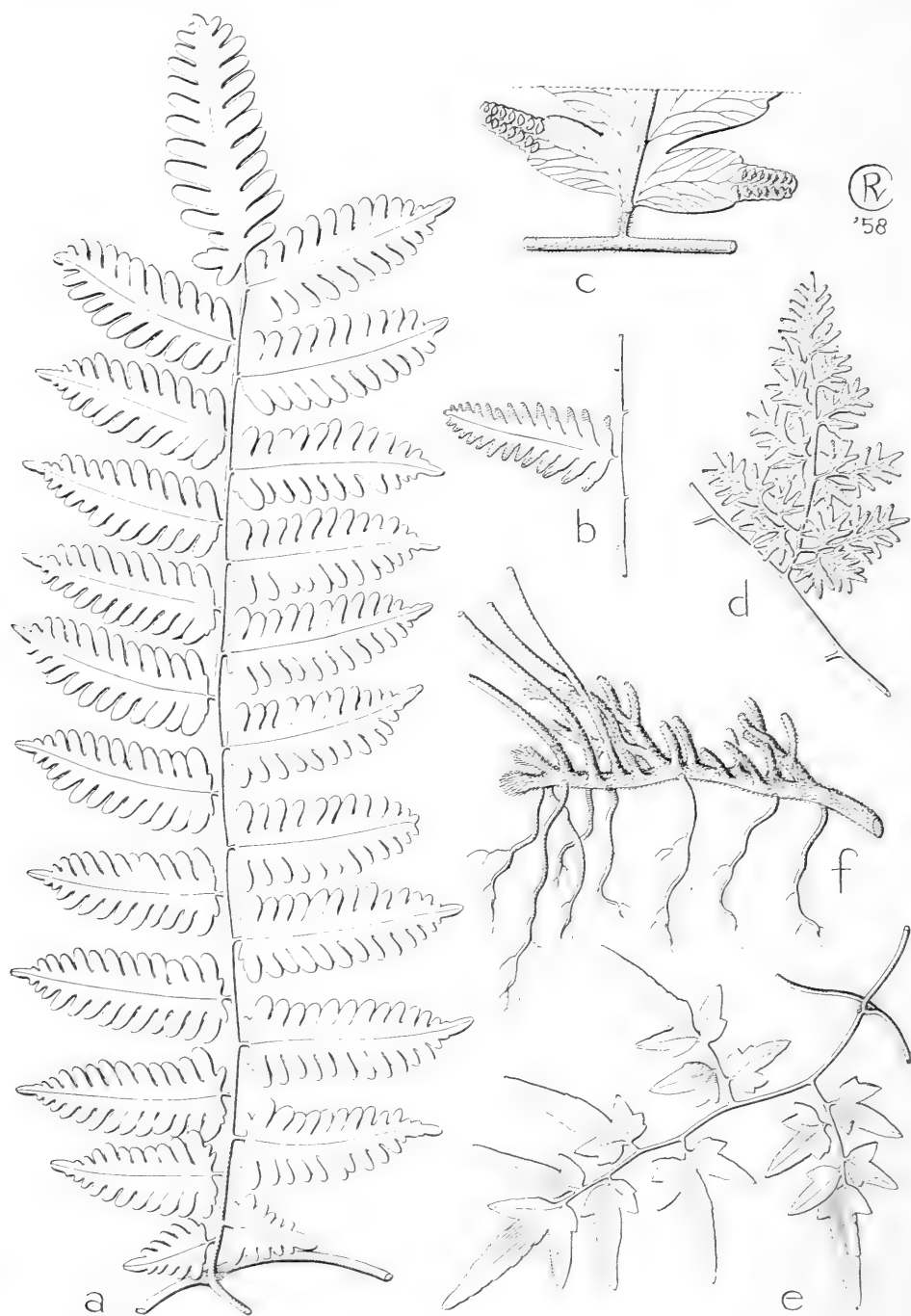


Fig. 8. *Lygodium polystachyum* WALL. ex MOORE. a. Sterile leaf,  $\times \frac{3}{5}$ , b. fertile leaflet,  $\times \frac{3}{5}$ , c. ditto, detail,  $\times 2\frac{1}{2}$ .—*L. japonicum* (THUNB.) SW. d. Fertile leaf,  $\times \frac{3}{5}$ , e. sterile leaf,  $\times \frac{3}{5}$ , f. rhizome,  $\times \frac{3}{5}$  (a BALANSA 168, b-c MATTHEW s.n., d, f cult. Kew, e SAVINIERRE 71).

Ecol. Edges of secondary forest, or climbing woody plants in open places, sometimes as a weed; in clay soil, or in swamps in regions subject to a dry season; from the lowlands to c. 1300 m.

Vern. *Ribu-ribu*, M., *sélada*, *capey papua*, *capay alus*, M., *paku kawat*, Sum., *paku hata bējas* (bias), *paku hata leutik*, S., *nitong-puti*, Tag., *paku rambat*, Bali, *sickey*, Luhea, *gomoha papua*, Ternate, *paku kawa*, Ambon, *paloge*, N. Celebes.

Uses. Native medicine (leaves macerated and mixed with lime for open wound), magic; young leaves edible; rachises of old leaves used for string and for plaiting.

**3. *Lygodium japonicum*** (THUNB.) SW. in Schrader, J. Bot. 1800, pt 2 (1801) 106; BEDD. Ferns S. India (1863) 21, t. 64; CLARKE, Trans. Linn. Soc. Bot. 1 (1880) 584; PRANTL, Unters. Morph. Gefässkr. 2 (1881) 68, t. 1 f. 10, 15; CHRIST, Pterid. Erde (1897) 355, 356, f. 1122; RACIB. Pterid. Buit. (1898) 8; HOPE, J. Bomb. Nat. Hist. Soc. 15 (1903) 106; v. A. v. R. Mal. Ferns (1908) 114; MERR. Fl. Manila (1912) 60; DOMIN, Bibl. Bot. 20, Heft 85 (1914) 211, f. 50; HAINES, Bot. Bih. & Or. 6 (1924) 1210; OGATA, Ic. Fil. Jap. 7 (1936) t. 322; BACKER & POSTH. Varenfl. Java (1939) 259; ALSTON & HOLTT. Reinwardtia 5 (1959) 14.—*Ophioglossum japonicum* THUNB. Fl. Jap. (1784) 328.—*Hydroglossum japonicum* (THUNB.) WILLD. Abh. Kurf. Mainz. Ak. Wiss. Erfurt 2, pt 4 (1802) 26.—*L. dissectum* DESV. Mag. Ges. Naturf. Fr. Berl. 5 (1811) 308.—*L. microstachyum* DESV. l.c.; NAKAI, Bot. Mag. Tokyo 39 (1925) 182; OGATA, Ic. Fil. Jap. 7 (1936) t. 323.—*L. pubescens* KAULF. En. Fil. (1824) 47, t. 1 f. 4.—*L. chaerophylloides* DESV. Mém. Soc. Linn. Paris 6 (1827) 205.—*L. cochinchinense* DESV. *ibid.* 206.—*L. tenue* BL. En. Pl. Jav. (1828) 254.—*L. microphyllum* LINK. Hort. Berol. 2 (1833) 141.—*L. japonicum* f. *elongata* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 1 (1911) 10, t. 3; Mall. Ferns Suppl. (1917) 117.—*L. japonicum* var. *microstachya* (DESV.) TARD. & C. CHR. Fl. Gén. I.-C. 7 (1939) 38.—*L. mearnsii* COPEL. Philip. J. Sc. 3 (1908) Bot. 37.—**Fig. 8d-f.**

Rhizome wide-creeping, dichotomously branched, 2–5 mm diameter, densely clothed with dark brown hairs, fronds commonly 5–10 mm apart. Juvenile fronds erect, the first branching an unequal dichotomy (always?), the two main branches of large fronds bipinnate, deltoid in outline, with palmatisect leaflets, their margins doubly serrate. *Rachis* of climbing fronds hardly 2 mm diameter, glabrous apart from minute hairs on the flattened adaxial surface between the narrow wings; primary rachis-branches 3–10 mm long, the dormant apex covered with pale hairs; *secondary branches* of fronds on young or stunted plants pinnate, on well-grown fronds bipinnate or tripinnate, deltoid in outline, commonly 12 cm long and wide, rachises densely short-hairy on the upper surface and bearing fewer longer hairs elsewhere; sterile tertiary *leaflets* of lower rachis-branches palmate with 5–7 lobes, the middle lobe much longer than the laterals, tertiary leaflets higher up the leaf trilobed with an elongate

middle lobe or pinnate with small oblique and often lobed quaternary leaflets and a usually deltoid-pinnatisect terminal leaflet about 3 cm long, edges acutely biserrate, apex obtuse or subacute; stalks of leaflets to 3 mm long, never articulate or thickened at the apex; costae usually bearing long scattered hairs, veins and surfaces usually glabrous but sometimes short-hairy; *fertile secondary branches* tripinnate, the leaflets smaller than sterile ones, *sorophores* 2–12 mm long; indusia glabrous or with a few hairs if the lamina is hairy; spores finely verrucose.

Type: Herb. Thunberg, Japan (Ups).

Distr. Ceylon, from Himalayas (Kashmir eastwards) to Chekiang in N. China, Korea, Japan (Nagasaki) and southwards to Siam and Indochina and southern China, naturalized in Florida and Texas; in *Malaysia*: Banka, Central and East Java, Celebes, Philippines, Moluccas (Ambon, Ternate, Banda Isl., Sula Isl.), Lesser Sunda Isl. (to Timor), and New Guinea.

Ecol. Climbing in secondary vegetation, at altitudes up to 2550 m; only found native in regions with a pronounced dry season, during which fronds perhaps die (no records in Malaysia); absent from Sumatra, Borneo and the Malay Peninsula (except perhaps the extreme north). Small forms are not always clearly distinct from *L. flexuosum*.

Vern. *Pakis kembang*, J., *paku areuj*, *hata kawat*, S., *nito*, *nitong puti*, Tag., *madik silai*, *durhawa*, *babar*, *talsiga*, Alor.

**4. *Lygodium salicifolium*** PRESL. Suppl. Pterid. (1845) 102, *p.p. excl. pl.* WALLICH *p.p.* and *syn.* RHEEDE; PRANTL, Unters. Morph. Gefässkr. 2 (1881) 79; v. A. v. R. Mal. Ferns (1908) 113; Bull. Jard. Bot. Btzig III, 5 (1922) 213; BACKER & POSTH. Varenfl. Java (1939) 258; TARD. & C. CHR. Fl. Gén. I.-C. 7, 2 (1939) 41; ALSTON & HOLTT. Reinwardtia 5 (1959) 14.—*L. kingii* COPEL. Philip. J. Sc. 6 (1911) Bot. 68; v. A. v. R. Mal. Ferns Suppl. (1917) 117.—*L. pinnatifidum* *sensu* RAC. Fl. Buit. (1898) 7, *p.p.*—*L. flexuosum* *sensu* HOLTT. Ferns Mal. (1955) 57, *p.p.*—**Fig. 6, 10, 13a-b.**

Rhizome and juvenile fronds as in *L. flexuosum*, except that the rachis is thickened at its junction with the midribs of the lobes of the leaflets. *Rachis* of climbing fronds to 2 mm diameter, to 10 m long; primary rachis-branches always very short (hardly measurable), ending in a dormant apex covered with brown hairs; *secondary rachis-branches* normally pinnate, rarely somewhat bipinnate and then the tertiary branches bearing one or more pairs of short spreading lateral leaflets (jointed at the base) and a large terminal one; secondary branch-system usually consisting of about 4 (rarely to 6) leaflets on each side, and a terminal deeply bilobed leaflet (or a pair of leaflets), all leaflets of about equal size and all stalked, the stalks 2–10 mm long and thickened at junction with lamina (old leaflets sometimes deciduous but not regularly so as in *L. microphyllum*); leaflets 4–15 cm long, ½–2 cm wide, acute

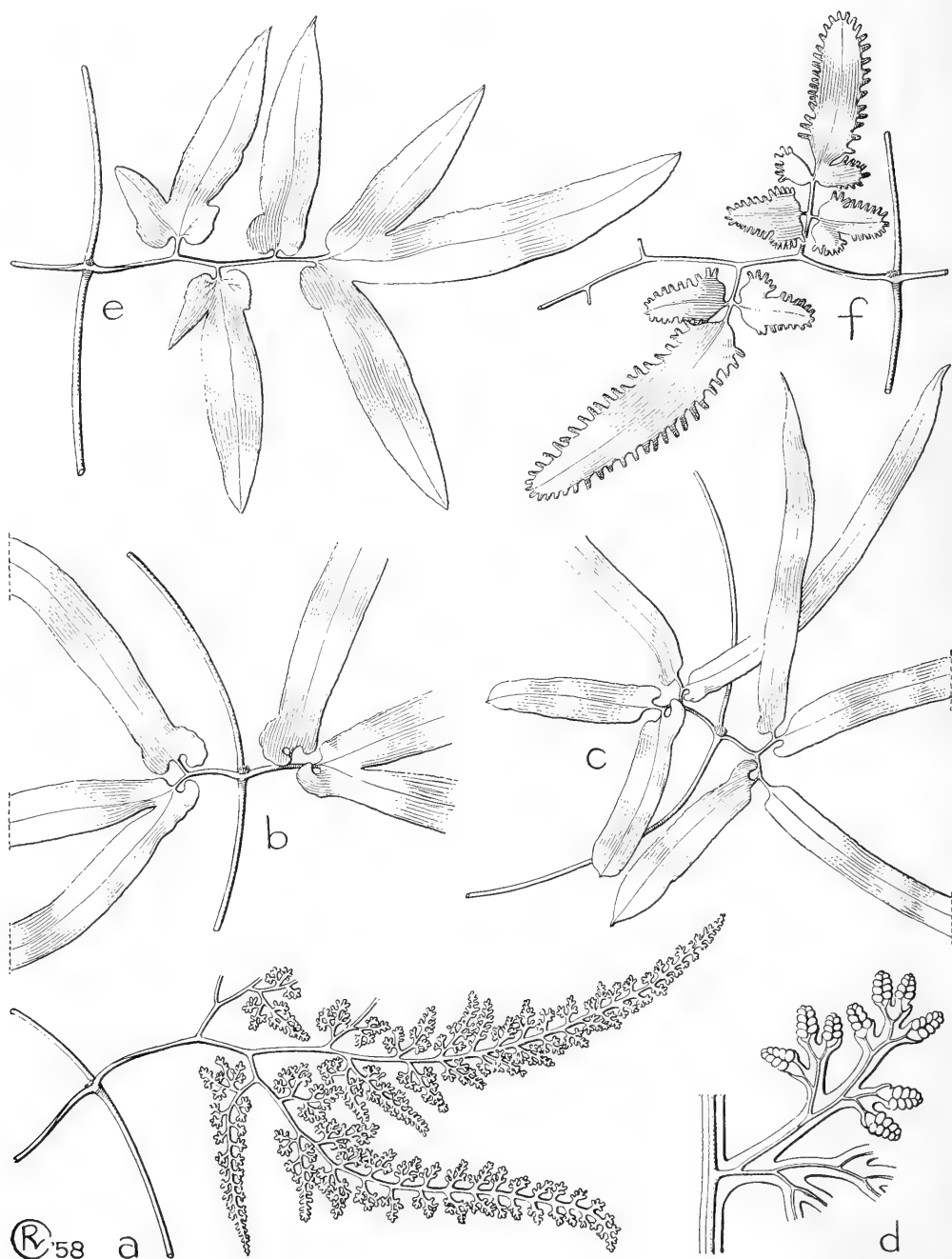


Fig. 9. *Lygodium dimorphum* COPEL. a. Part of fertile leaf,  $\times \frac{2}{3}$ , b-c. parts of sterile leaves,  $\times \frac{2}{3}$ , d. detail of a,  $\times 3$ .—*L. flexuosum* (L.) Sw. e. Sterile leaf,  $\times \frac{2}{3}$ , f. fertile leaf,  $\times \frac{2}{3}$  (a LABILLARDIÈRE s.n., b-c CARR 12479, d PEEKEL 6, e HOSE 5024, f HALLIER s.n. from Java).

and attenuate or subobtusely, edges of sterile leaflets finely crenate-serrate, base truncate to cordate, lamina thicker than in *L. flexuosum*; upper surface of costae more or less hairy especially towards the base, lower surface often glabrous, veins usually glabrous; *sorophores* 2–5 mm long, usually constricted at the base, often with hairs on upper surface of midrib; indusia glabrous; spores finely verrucose.



Fig. 10. 'Columns' of *Lygodium salicifolium* Pr. on scattered pole trees of mostly *Ilex cymosa*, surrounded by a dense ground cover of ferns and sedges, *Nepenthes*, and orchids, in an old crater swamp in the Gajo Lands, N. Sumatra, c. 1200 m (1937).

Type: Cuming 365, Singapore (W, K).

Distr. Assam, Siam, Indochina to Yunnan, Formosa, south-east to New Guinea and Micronesia; in *Malaysia*: Sumatra, Malay Peninsula, Banka, W. Java, Borneo, and New Guinea.

Ecol. In open secondary vegetation, sometimes in wet places, in the low country and to 1200 m; reported in teak forest in West Java.

Note. There are specimens which are intermediate between this species and *L. flexuosum*; they may be hybrids. *L. salicifolium* occurs only in regions with a short dry season, whereas *L. flexuosum* will tolerate a longer dry season and has a wider distribution. In Burma and Assam very large forms of both species occur.

Vern. *Hata*, S, *mintuh*, Dayak, *paku kawat*, Sum., *akar sidin*, M.

5. *Lygodium flexuosum* (L.) Sw. in Schrader, J. Bot. 1800, pt 2 (1801) 106; *ibid.* 1801, pt 2 (1802) 304; PRESL, Suppl. Pterid. (1845) 100; BEDD. Ferns S. India (1863) t. 63; CLARKE, Trans. Linn. Soc. Bot. 1 (1880) 584; PRANTL, Unters. Morph. Gefässkr. 2 (1881) 72, p.p.; BEDD. Handb. (1883) 457, f. 283; v. A. v. R. Mal. Ferns (1908) 114; MERR. Fl. Manila (1912) 61; DOMIN, Bibl. Bot. 20, Heft 85 (1914) 209, f. 49; HAINES, Bot. Bih. & Or. 6 (1924) 1211; BACK. Onkr. Suiker 7 (1928) 1, t. 1; BURK. Dict. 2 (1935) 1378; C. CHR. Dansk Bot. Ark. 9, pt 3 (1937) 30; BACKER & POSTH. Varenfl. Java (1939) 259; HOLTT. Ferns Mal. (1955) 57, p.p.; ALSTON & HOLTT. Reinwardtia 5 (1959) 15.—*Ophioglossum flexuosum* LINNÉ, Sp. Pl. (1753) 1063.—*Ophioglossum scandens* LINNÉ, Sp. Pl. (1753) 1063, p.p.—*Ramondia flexuosa* (L.) MIRB. Bull. Soc. Philom. Paris 2 (Feb.–Mar. 1800) 179, t. 12 f. 3.—*Hydroglossum flexuosum* (L.) WILLD. Abh. Kurf. Mainz. Ak. Wiss. Erfurt 2 (1802) 23, t. 1 f. 3.—*Hydroglossum pinnatifidum* WILLD. *ibid.* 21, p.p.—*L. pinnatifidum* Sw. in Schrader, J. Bot. 1801, pt 2 (1803) 303; Hook. Syn. Fil. (1868) 438, p.p.—*L. semibipinnatum* R. Br. Prod. Fl. Nov. Holl. (1810) 162.—*L. serrulatum* BL. En. Pl. Jav. (1828) 254.—*L. flexuosum* var. *setulosum* TARD. & C. CHR. Fl. Gén. I.-C. 7 (1939) 39.—Fig. 9e-f.

Rhizome short-creeping and densely covered with roots, the stipes very close together; apex of rhizome covered with dark brown to nearly black hairs. Juvenile fronds once or twice dichotomous, each branch bearing a single leaflet which is deeply palmately 3–7-lobed, the lobes almost equal, the base of the whole leaflet cordate, edges serrate and sometimes crenately lobed. *Rachis* of scandent fronds narrowly winged, flattened and puberulous on the upper surface between the wings; primary *rachis*-branches up to 3 mm long (lower ones longest), dormant apex covered with pale brown hairs; *secondary rachis*-branches pinnate to somewhat bipinnate, narrowly ovate to deltoid in outline, commonly about 15 cm long and 8 cm wide; sterile leaflets of lower branches palmate, often 5-lobed, base strongly cordate; higher secondary branches bearing 3–5 (sometimes to 7) leaflets on each side and an apical one, the apical and lower leaflets asymmetric or more or less lobed at the base, the lowest often with 2 or 3 (exceptionally to 6) separate quaternary leaflets at its base; *sterile leaflets* 3–10 cm long, 8–15 mm wide above the lobed base, apex subacute, edges serrate, lower leaflets stalked, upper sessile, lamina rather thin; costae usually bearing scattered long hairs, less often densely short-hairy, veins often with scattered short hairs on the lower surface, the lamina sometimes similarly hairy; *fertile leaflets* smaller than sterile, *sorophores* 3–5 mm long (rarely up to 10 mm), at the apices of small triangular lobes; indusia glabrous or with a few hairs like those of the lower surface of the lamina; spores finely verrucose.



Type: Hermann, Ceylon (BM).

Distr. Ceylon, from the Himalayas (Dehra Dun eastwards) to southern China, Hong Kong, Riu Kiu Isl., south and south-east to Melanesia and northern Queensland, throughout *Malaysia*.

Ecol. In open places, climbing on shrubs, in teak and bamboo forest, in low country and to 1000 m, not in shady evergreen forest. In very dry or exposed places the veins and lamina are often rather copiously hairy.

Vern. *Ribu-ribu gajah*, *ribu-ribu bĕsar*, *ikat sidin*, *M*, *paku ribu-ribu*, Asahan, *hata kĕmbang*, *J*, *durhawa*, Alor, *nito*, Tag., Visc., *tatan*, Orokawa Horata (N.G.), *zangi*, Orokawa Mumuni.

Uses. For tying rice sheaves; in native medicine for skin diseases and fever.

**6. *Lygodium dimorphum*** COPEL. Philip. J. Sc. 6 (1911) Bot. 67; ROSENST. in Fedde, Rep. 10 (1912) 343; v. A. v. R. Mal. Ferns Suppl. (1917) 116; Philip. J. Sc. 11 (1916) Bot. 116; ALSTON & HOLTT. Reinwardtia 5 (1959) 18.—*L. flexuosum* [non (L.) Sw.] GAUDICH. in Freyc. Voy. Bot. (1826) 298.—*L. circinnatum* var. *trifurcatum* CHRIST, Monsunia 1 (1900) 93.—*L. novoguineense* ROSENST. in Fedde, Rep. 9 (1911) 427.—*L. trifurcatum* sensu v. A. v. R. Mal. Ferns (1908) 112, 802, p.p.—Fig. 9a-d.

Rhizome short-creeping, bearing fronds very close together, apex densely covered with almost black hairs. Juvenile fronds once dichotomous, each branch bearing a deeply palmatisect leaflet, lobes subequal, base cordate, edges rather irregularly serrate and somewhat thickened. *Rachis* of climbing fronds hardly 2 mm diameter, glabrous or nearly so; primary *rachis*-branches very short, ending in a somewhat projecting dormant bud covered with light brown hairs having slightly swollen bases; *secondary rachis*-branches bearing sterile leaflets unbranched or more commonly once dichotomous, those bearing fertile leaflets usually sub-pinnate with a few tertiary branches; *sterile leaflets* 10–18 cm long, simple or forked (less often 3-lobed), usually strongly cordate and auriculate at the base on one side (sometimes with a separate rounded leaflet replacing the cordate base), when forked the lamina lobed to within 1 cm of the base, leaflets or lobes 1–2 cm wide, tapering, acute, irregularly doubly serrate, edge somewhat thickened, surfaces glabrous, sometimes sparingly warty; *fertile leaflets* usually with the lamina reduced to a narrow wing (0.2 mm wide) along the costae and along each vein and its branches; tertiary fertile branches deltoid in outline (5 cm or more wide at the base), with quaternary leaflets of increasing length below each terminal one; *sorophores* 2–4 mm long, indusia glabrous; spores minutely verrucose on an unevenly undulating surface (always?).

Type: C. King 134, Papua (MICH, Bo).

Distr. *Malaysia*: Celebes (?), Moluccas (Ambon, Rawak), New Guinea.

Ecol. "Climbing small trees to a height of about 12 feet. Quite common in low wet places along the coast" (RUSSELL, on specimen from

E. New Guinea). Collections have also been made inland, at altitudes up to 1000 m.

Vern. *Canā*, Motuan, *gailei*, Bragi, *paku kawa*, Ambon.

Uses. Used for making arm- and leg-bands.

**7. *Lygodium trifurcatum*** BAK. in Hook. Syn. Fil. (1868) 437; v. A. v. R. Mal. Ferns (1908) 112, 802, p.p.; WAGNER & GREYER, Un. Cal. Publ. Bot. 23 (1948) 27, t. 8; ALSTON & HOLTT. Reinwardtia 5 (1959) 17.

Scandent *rachis* about 1½ mm diameter; primary *rachis*-branches very short, hairs on the dormant apex having swollen bases; *sterile secondary rachis*-branches once or twice equally or sub-equally dichotomous (12–20 mm to first dichotomy), the leaflets simple or very deeply bilobed, 10–20 cm long, 1½–2½ cm wide, the outer base of each more or less cordate (rarely strongly auriculate), edges irregularly serrate and slightly thickened; *fertile secondary branches* usually sub-pinnate with flexuous axis bearing two lateral and one terminal leaflets, sometimes twice symmetrically dichotomous; fertile leaflets usually deeply bilobed or geminate, one or both members often having a shorter lobe commonly 9–15 cm long and up to 13 mm wide including sorophores, lamina reduced to a wing along the costa and along each vein-group (sometimes two adjacent vein-groups with a common lamina) the *sorophores* thus in groups of 2–5; sorophores usually 2–3 mm long; spores coarsely and unevenly verrucose, the warts often confluent.

Type: Milne 511, Solomon Isl. (K).

Distr. Melanesia (Solomon Isl. and New Hebrides); in *Malaysia*: Admiralty Isl., Louisiades.

Ecol. "Climbing abundantly in brackish marsh" (GREYER & WAGNER 3997, Admiralty Islands).

Note. The specimen of GREYER & WAGNER has fertile branches more like those of *L. dimorphum* than is usual in *L. trifurcatum*, and has one branch intermediate between sterile and fertile; the fully sterile leaflets are smaller than normal in *L. dimorphum* and only slightly cordate at the base. The two species are very closely allied, and it may be that in the Admiralty Islands, where their areas of distribution overlap, there has been hybridization.

**8. *Lygodium auriculatum*** (WILLD.) ALSTON, Reinwardtia 5 (1959) 16.—*Ugena semihastata* CAV. Ic. Descr. Pl. 6 (1801) 74, t. 594, *nomen illegit.*, *excl. syn.* REICHARD & RUMPH.; C. B. ROB. Philip. J. Sc. 6 (1911) Bot. 97; C. CHR. Dansk Bot. Ark. 9, pt. 3 (1937) 29.—*Hydroglossum auriculatum* WILLD. Sp. Pl. 5 (1810) 84.—*L. semihastatum* DESV. Mém. Soc. Linn. Paris 6 (1827) 203, *nom. illeg.*; Hook. Syn. Fil. (1868) 437; v. A. v. R. Mal. Ferns (1908) 111, *excl. pl. borneensis*; Mal. Ferns Suppl. (1917) 115; C. CHR. Ind. Fil. Suppl. I (1913) 119.—*L. circinnatum* var. *semihastatum* Fosb. Am. Fern J. 40 (1941) 142.—*L. flexuosum* [non (L.) Sw.] PRANTL, Unters. Morph. Gefässkr. (1881) 73, p.p. *quoad syn.* CAV. and WILLD.—Fig. 11.



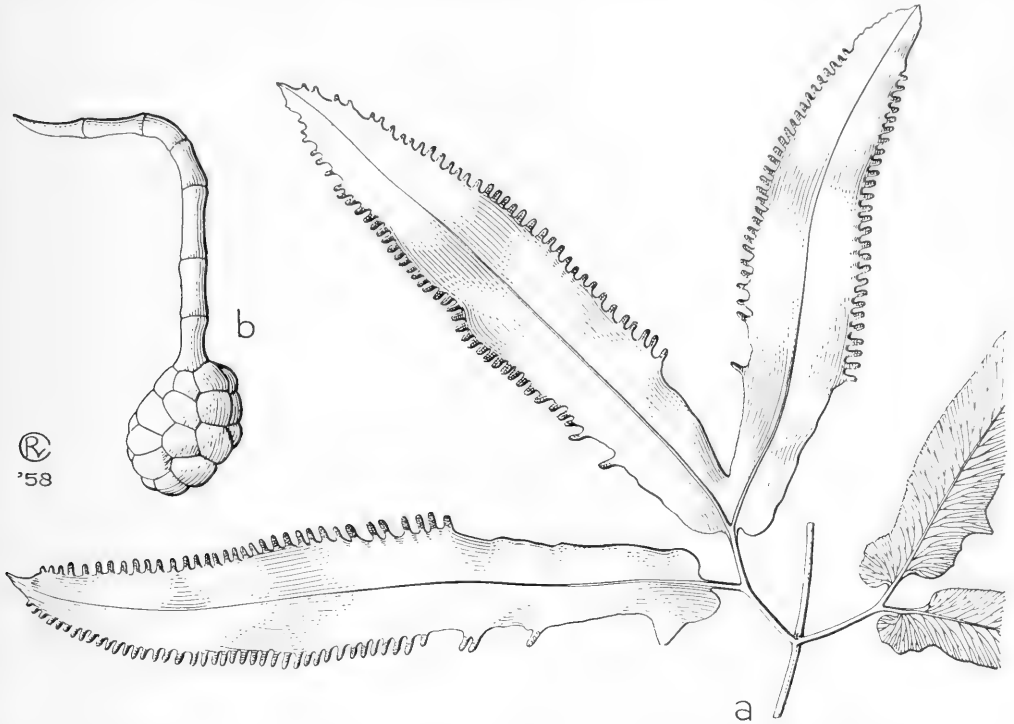


Fig. 11. *Lygodium auriculatum* (WILLD.) ALSTON. a. Habit,  $\times \frac{2}{3}$ , b. hair,  $\times 65$  (a-b LE ROY TOPPING 1287).

Rhizome short-creeping, bearing fronds close together, its apex and bases of stipes densely covered with dark hairs. Juvenile fronds once dichotomous, each branch bearing a palmatisect leaflet, usually 5-lobed, with truncate base, edges closely and irregularly serrate. *Rachis* of climbing fronds hardly 2 mm diameter, usually glabrous; primary rachis-branches very short, dormant apex covered with pale brown hairs having swollen bases; *secondary rachis-branches* rarely bearing a simple leaflet, most commonly once dichotomous, one branch with a simple, one with a forked leaflet, less often each branch with a simple leaflet; *sterile leaflets* 12–20 cm long, 12–30 mm wide, subacute, edges not thickened, very shallowly serrate, base usually asymmetric and strongly cordate-auriculate on the outer, rarely on both sides, costae glabrous except near the base on upper surface; lamina of *fertile leaflets* 12–20 mm (rarely to 30 mm) wide, *sorophores* 3–9 mm long, constricted at the base, at the apices of short triangular lobes of the lamina; indusia glabrous; spores irregularly warty, variable as between different specimens, in some cases resembling those of *L. longifolium*, in others with many smaller warts of variable size.

Type: Née, Luzon (MA).

Distr. Indochina, Micronesia; in *Malaysia*: E. Borneo, Philippines (Polillo, Luzon, Mindoro,

Samar, Mindanao), to 600 m altitude.

Note. The Micronesian specimens seen (from Guam) are all smaller than Philippine ones, and their secondary branches are regularly twice dichotomous; they may constitute a distinct local race (specimens of Née from Marianas not seen). It may be that this species intergrades with *L. borneense* in Borneo.

Vern. *Nito*, Tag.

Uses. Climbing rachises used for weaving, making hats, and magic (contra-poison) bracelets.

9. *Lygodium borneense* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 20 (1915) 29; Mal. Ferns Suppl. (1917) 115; COPEL. Sarawak Mus. J. 2 (1917) 303; HOLTT. J. R. As. Soc. Mal. Br. 6 (1928) 16 with fig.; Ferns Mal. (1955) 56.—*L. semi-hastatum* sensu v. A. v. R. Mal. Ferns (1908) 111, p.p. *quoad pl. borneenses*.—*L. borneense* f. *samarindae* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 20 (1915) 29; Mal. Ferns Suppl. (1917) 116.—Fig. 5b, 13c–e.

*Rachis* of scandent fronds glabrous, up to 2 mm diameter; primary rachis-branches very short, dormant apex covered with pale hairs having swollen bases; secondary rachis-branches rarely unbranched, normally once dichotomous (10–20 mm long below the dichotomy), each branch

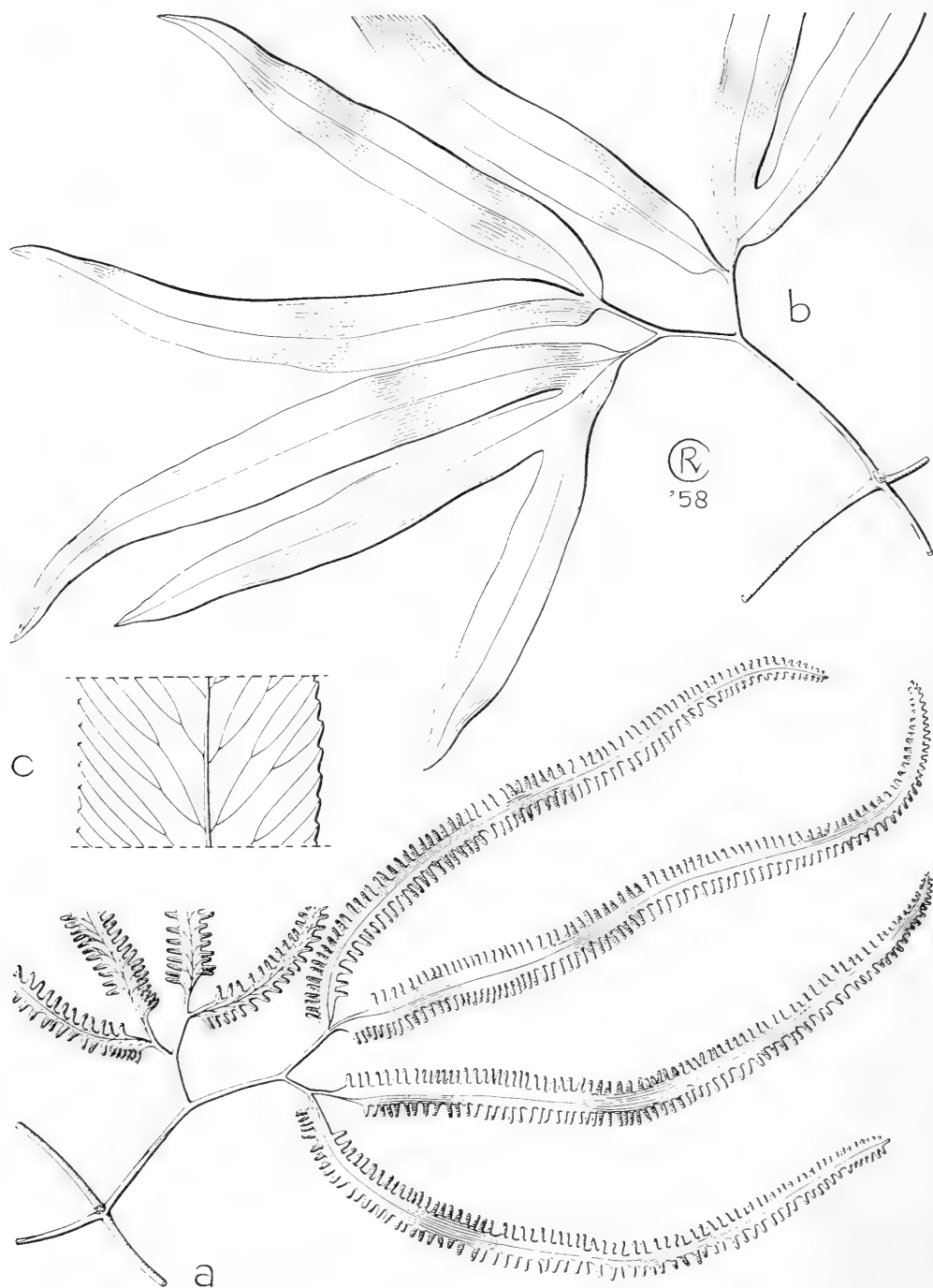


Fig. 12. *Lygodium longifolium* (WILLD.) SW. *a*. Habit, fertile,  $\times \frac{2}{3}$ , *b*. sterile,  $\times \frac{2}{3}$ , *c*. leaf detail showing edge,  $\times 3$  (*a* KING's coll. 259, *b* MOTLEY s.n., *c* HOSE 5034).

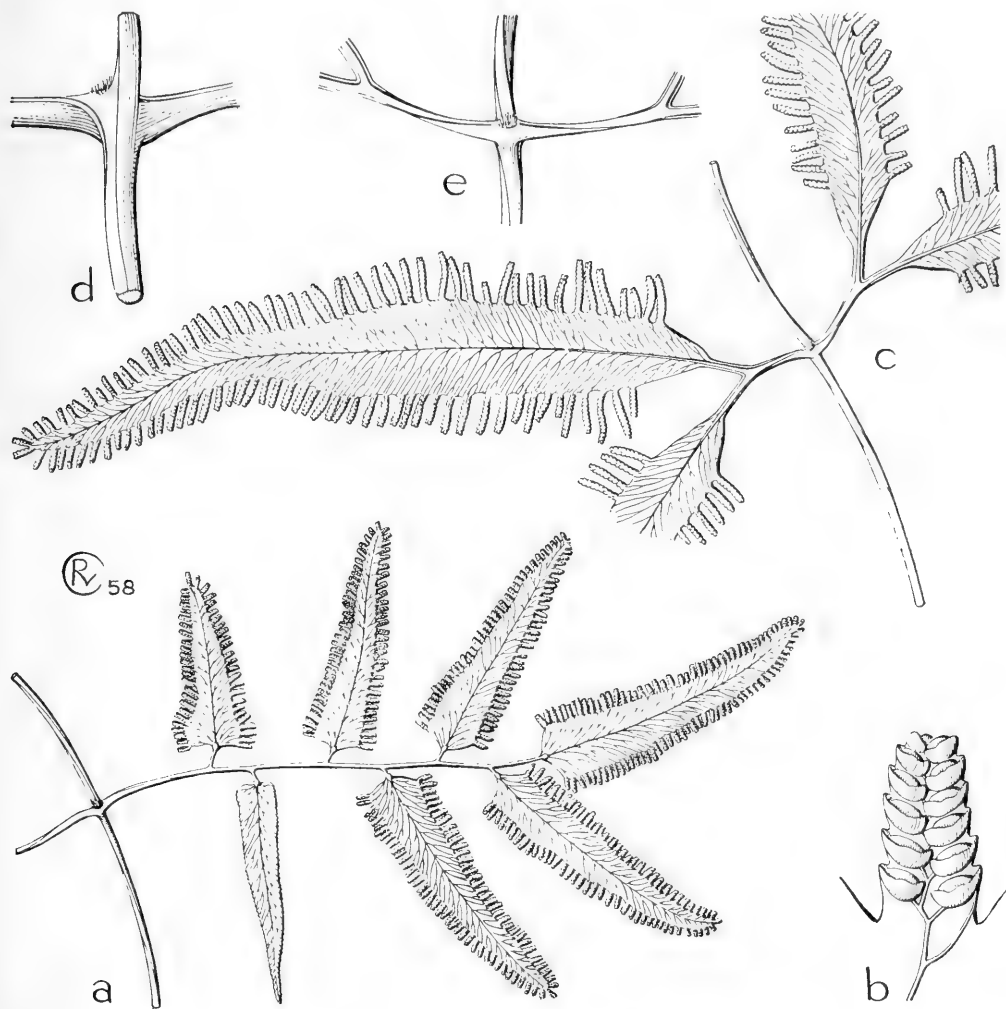


Fig. 13. *Lygodium salicifolium* PR. a. Habit,  $\times \frac{2}{3}$ , b. detail,  $\times 10$ .—*L. borneense* v. A. v. R. c. Habit,  $\times \frac{2}{3}$ , d. detail of branching,  $\times \frac{2}{3}$ , e. ditto,  $\times \frac{4}{3}$  (a BERKHOUT s.n., b BRASS 5686, c SFN 18656, d-e ENDERT 2057).

with a simple leaflet or rarely one leaflet double, rarely the secondary branch-system sub-pinnate with two lateral and one terminal leaflets; *sterile leaflets* 20–35 cm long (on upper parts of frond smaller),  $3\frac{1}{2}$ –5 cm wide, margin more or less distinctly serrulate and slightly thickened, base cuneate (rarely cordate on the outer base), surfaces quite glabrous except the upper surface of the costa towards its base, lamina not verrucose when dry; *fertile leaflets* similar to sterile but slightly smaller, 10–30 cm long, 12–40 mm wide (smallest on upper branches), *sorophores* 4–10 mm long, usually about 2 mm apart, at the apices of small triangular projections of the lamina; spores quite smooth.

Type: Teysmann, Borneo (Bo).

Distr. *Malaysia*: Malaya (SE. Johore only), Sumatra (Mentawai Isl.), Borneo (many localities), Talud Isl.

Ecol. In light places in freshwater swamp-forest; in Sarawak twice reported in the neighbourhood of limestone hills but certainly occurring also not in the vicinity of limestone; one specimen from Sarawak, found growing with *Imperata* on sandy ground, has unusually small leaflets.

Note. This species has a branching habit closely similar to that of *L. auriculatum*. *L. borneense* usually differs from *L. auriculatum* in the larger size and cuneate base of its leaflets, but some Bornean specimens seem to be intermediate in

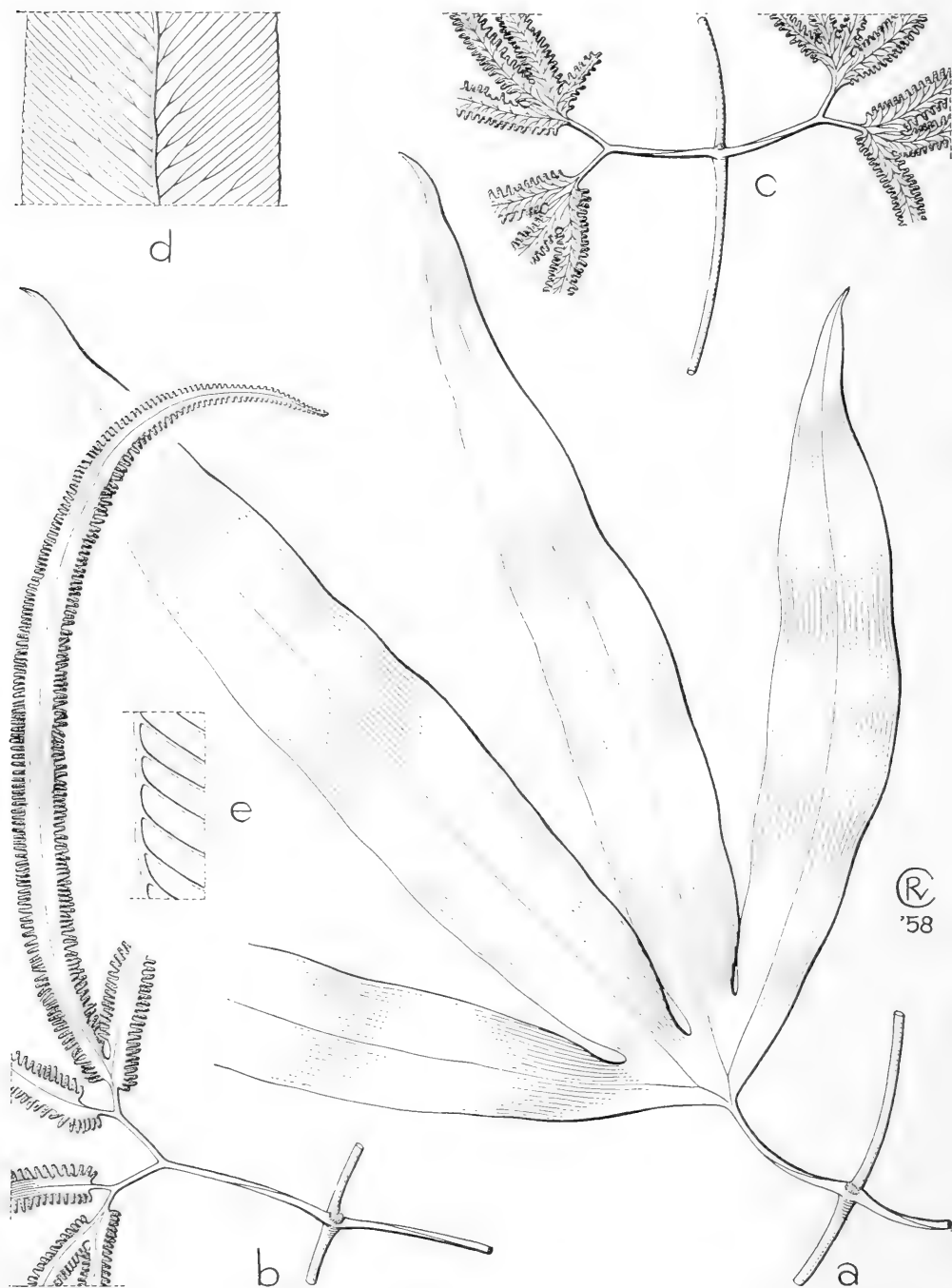


Fig. 14. *Lygodium circinnatum* (BURM. f.) Sw. a. Part of sterile leaf,  $\times \frac{2}{3}$ , b-c. parts of fertile leaves, showing different kinds of branching,  $\times \frac{2}{3}$ , d. veins of sterile leaf,  $\times 3$ , e. ditto, leaf edge,  $\times 9$  (a, d-e CLEMENS 9487, b ZOLLINGER 169, c Lady DALHOUSIE s.n.).

the latter character. So far as observed, *L. borneense* seems to be consistent in its smooth spores.

**10. *Lygodium longifolium* (WILLD.) Sw.** in Schrader, J. Bot. 1801, pt 2 (1803) 305; ALSTON & HOLTT. Reinwardtia 5 (1959) 19.—*Hydroglossum longifolium* WILLD. Abh. Kurf. Mainz. Ak. Wiss. Erfurt 2, pt 4 (1802) 22, t. 2.—*L. digitatum* PRESL, Rel. Haenk. 1 (1825) 73 (?); v. A. v. R. Mal. Ferns (1908) 112; HOLTT. Ferns Mal. (1955) 55.—*L. dichotomum* (non (CAV.) Sw.) BEDD. Ferns S. India (1863) t. 62.—*L. teysmannii* v. A. v. R. Bull. Dép. Agr. Ind. Néerl. 18 (1908) 5; Mal. Ferns (1908) 111, 801; Mal. Ferns Suppl. (1917) 115.—*L. circinnatum* var. *cristatum* v. A. v. R. Bull. Dép. Agr. Ind. Néerl. n. 18 (1908) 5; Mal. Ferns (1908) 112, 802.—*L. derivatum* v. A. v. R. Bull. Jard. Bot. Btzg III, 5 (1922) 213.—**Fig. 5a, 12.**

Rhizome short-creeping, its apex and bases of stipes covered with shining black hairs. Juvenile fronds once or twice dichotomous, leaflets palmately divided with 4–7 subequal lobes, base often more or less cordate, lobes to about 18 cm long and 18 mm wide, acuminate, edges shallowly serrate, a vein ending in each tooth. Scandent frond to about 4 m long, rachis to 2 mm diameter; primary rachis-branches very short, with a dormant apex covered with brown hairs having small swollen bases; *secondary rachis-branches* 1–3 times dichotomous or sub-pinnate (lowest ones sometimes unbranched and bearing large 6-lobed leaflets); *sterile leaflets* composed of 2–4 subequal lobes 15 cm or more long and c. 15 mm wide, the sinuses between the lobes reaching to 15 mm from the base of the leaflet, edges regularly serrate, not or little thickened, base cuneate to cordate, surfaces glabrous and usually not warty when dried; *fertile secondary branches* 1–3 times dichotomous or (if the dichotomies are unequal) more or less distinctly pinnate with two dichotomous tertiary branches (tertiary branches may rarely have three separate leaflets); *fertile leaflets* simple or more usually consisting of two subequal lobes united at the base, lamina 3–10 mm wide, *sorophores* commonly 2–3 mm long, less often to 6 mm; spores coarsely and irregularly verrucose.

Type: Herb. Willdenow, Malabar (B).

Distr. Southern India, Hainan; in *Malaysia*: Malaya, Riouw and Lingga Islands, Sumatra, Borneo, Luzon (doubtful).

Ecol. Edges of forest, probably in more exposed places than *L. circinnatum*, and not attaining so large a size as that species.

**11. *Lygodium circinnatum* (BURM. f.) Sw.** Syn. Fil. (1806) 153; BL. En. Pl. Jav. (1828) 253; PRANTL, Unters. Morph. Gefässkr. 2 (1881) 64; BEDD. Handb. (1883) 455; v. A. v. R. Mal. Ferns (1908) 111; C. B. ROB. Philip. J. Sc. 6 (1911) Bot. 102; v. A. v. R. Philip. J. Sc. 11 (1916) Bot. 116; MERR. Int. Rumph. (1917) 69; v. A. v. R. Mal. Ferns Suppl. (1917) 115; W. H. BROWN, Bull. Bur. For. Philip. n. 19 (1919) t. 4; *ibid.*

n. 22 (1920) 328, pl. IV; HEYNE, Nutt. Pl. (1927) 96; BACK. Krakatoa (1929) 253; BURK. Dict. 2 (1935) 1378; BACKER & POSTH. Varenfl. Java (1939) 258, f. 67; HOLTT. Ferns Mal. (1955) 55, f. 9; ALSTON & HOLTT. Reinwardtia 5 (1959) 20.—*Ophioglossum circinnatum* BURM. f. Fl. Ind. (1768) 228.—*Ophioglossum pedatum* BURM. f. *ibid.* 227, t. 66 f. 1.—*Ugena dichotoma* CAV. Ic. Descr. Pl. 6 (1801) 74, t. 594 f. 2; C. CHR. Dansk Bot. Ark. 9, pt 3 (1937) 30.—*L. pedatum* (BURM. f.) Sw. Syn. Fil. (1806) 154; MERR. Philip. J. Sc. 19 (1921) 336.—*Hydroglossum circinnatum* (BURM. f.) WILLD. Abh. Kurf. Mainz. Ak. Wiss. Erfurt 2, pt 4 (1802) 24.—*Hydroglossum pedatum* (BURM. f.) WILLD. *ibid.* 25.—*L. dichotomum* (CAV.) Sw. Syn. Fil. (1806) 154; HOOK. & GREV. Ic. Fil. 1 (1831) t. 55; HOOK. & BAK. Syn. Fil. (1868) 437; RACIB. Pterid. Buit. (1898) 8.—*Ophioglossum furcatum* ROXB. Calc. J. Nat. Hist. 4 (1844) 478.—*L. basilanicum* CHRIST, Philip. J. Sc. 2 (1907) Bot. 179; v. A. v. R. Mal. Ferns (1908) 802.—*L. circinnatum* var. *monstruosum* v. A. v. R. Bull. Dép. Agr. Ind. Néerl. n. 18 (1908) 5; Mal. Ferns (1908) 112; Mal. Ferns Suppl. (1917) 115.—**Fig. 5d, 14.**

Rhizome short-creeping, bearing stipes very close together, its apex and bases of stipes densely covered with black hairs. Juvenile fronds once dichotomous, each branch bearing a pedately palmatisect leaflet, lobes usually 4 or 5, subequal, to about 25 by 3½ cm, the midrib of an outer lobe arising near base of the next inner lobe, edges entire, often somewhat crisped, pale and much thickened (translucent when living), apices acute to acuminate, surfaces glabrous but conspicuously warty when dry (not when living), veins uniting with the thickened margin. *Rachis* of climbing frond to about 10 m long, 2–5 mm diameter, glabrous; primary rachis-branches very short, with sunken dormant apex covered with pale hairs which are not thickened at the base; *secondary rachis-branches* unbranched and 2–6 cm long, or once dichotomous with each branch 1–2 cm long beyond the fork; *sterile leaflets* usually with 2–6 subequal diverging lobes which are separate to within 2 cm from the base, entire, margin pale and thickened, base cuneate or truncate, surfaces nearly always warty when dry; *fertile secondary rachis-branches* unbranched or 1–3 times dichotomous (rarely sub-pinnate); *fertile leaflets* usually sessile in pairs at the ends of the ultimate branches, or members of a pair partly fused at the base, less often 3–5-lobed (always so if the secondary rachis is unbranched), lamina more or less reduced and commonly 3–6 mm wide, rarely less than 2 mm or approximating in width to the sterile leaflet-lobes; *sorophores* 2–5 mm long, sessile; spores finely and evenly verrucose.

Type: Java, herb. Burman (G, not seen).

Distr. Ceylon, NE. India to southern China, Siam and Nicobar Isl. to Micronesia, the New Hebrides and Solomons; throughout *Malaysia*.

Ecol. In lightly shaded places in primary or secondary forest, in the lowlands and to 1500 m

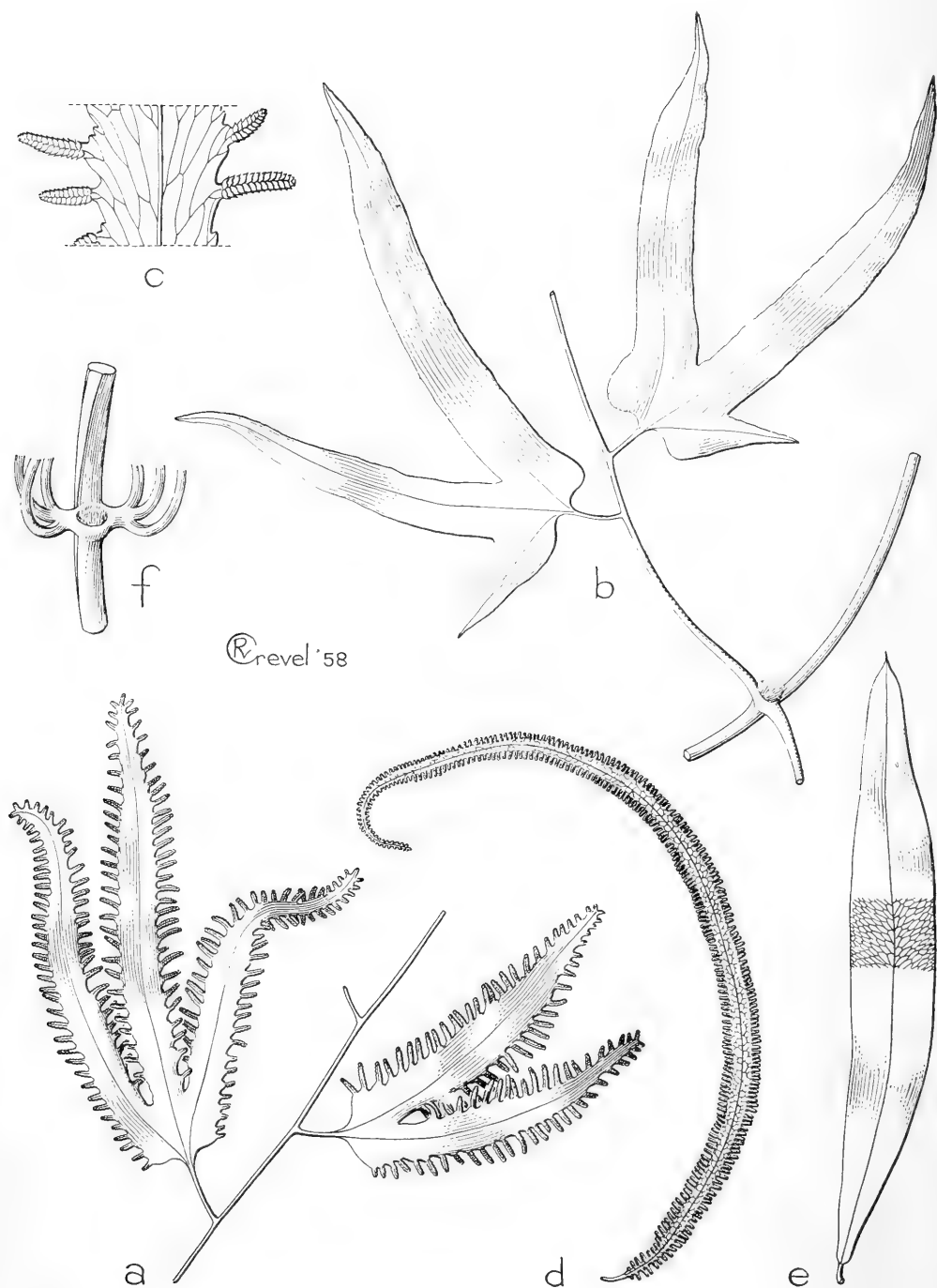


Fig. 15. *Lygodium merrillii* COPEL. a. Part of fertile leaf,  $\times \frac{1}{2}$ , b. part of sterile leaf,  $\times \frac{1}{2}$ , c. detail of fertile leaf,  $\times 1\frac{1}{2}$ .—*L. versteegii* CHRIST. d. Part of fertile leaf,  $\times \frac{1}{2}$ , e. part of sterile leaf,  $\times \frac{1}{2}$ , f. detail, main rachis bearing a primary branch with its secondary branches, each ultimate branch bearing a single leaflet like those shown in d and e,  $\times 2$  (a, c MABESA 26112, b TOPPING 1318, d-f LAM 1386).

altitude, never where the ground becomes seasonally very dry.

Vern. *Ribu-ribu dudok*, *ribu-ribu bukit*, *paku jari merah*, *akar sidin*, *kapai bĕsar*, *rĕribu*, M., *tura*, Nias, *kapai gorita*, Mol., *paku hata*, *hata areuj*, S., *paku ata*, *paku ribu-ribu*, Asahan, *paku rambat*, J., *ata*, Bali, *babar*, Alor, *masĕm*, Minah., *raga-raga*, Mak., *tjiwang*, Bug., *mongodo*, Tob., *gomoho*, Tern., *gomongo*, Tidore, *nito*, Tag., Visc.

Uses. Medicinal, and for plaiting. In the Philippines used for making hats and cigarette cases, in Ambon for adorning houses for marriage festivals, in Sumatra in rice ceremonies. Young leaves edible.

**12. *Lygodium merrillii*** COPEL. Philip. J. Sc. 2 (Apr. 1907) Bot. 146, t. 4; *ibid.* 4 (1909) Bot. 20, t. 12; v. A. v. R. Mal. Ferns (1908) 803; Mal. Ferns Suppl. (1917) 118.—*L. matthewii* COPEL. Philip. J. Sc. 3 (1908) Bot. 36; *ibid.* 4 (1909) Bot. 20; v. A. v. R. Mal. Ferns (1908) 803.—**Fig. 15a-c.**

Rhizome and juvenile fronds not seen. *Rachis* of scandent fronds to 5 mm diameter, minutely hairy (hairs slender and erect), near base also bearing long dark hairs like those on dormant apices; primary rachis-branches very short, dormant apices prominent, covered with long dark brown hairs; secondary rachis-branches unifoliate and sterile near the base of a frond, upper ones pinnate; unifoliate secondary branches 6–9 cm long, leaflets c. 25 cm long, palmately 5–6-lobed with acute sinuses to within 6 cm of the base, lobes 2½–4 cm wide, acute and acuminate, shallowly and irregularly crenate-serrate, margin not thickened, veins oblique, anastomosing, with about four rows of elongate areoles between costa and margin, lower surface of lamina and of veins minutely hairy or glabrous; largest upper sterile secondary rachis-branches pinnate, with 2–4 lateral deeply bilobed or palmate leaflets (on stalks to 3 cm long) and a terminal one; fertile secondary rachis-branches pinnate (or the largest bipinnate at the base), in all 30 cm or more long, with 5–7 leaflets which are 2–4-lobed; fertile leaflets 8–10 cm long, lamina of each lobe to 1½ cm wide, veins anastomosing, stalks 5–15 mm long; sorophores 7–15 mm long, somewhat contracted at base, indusia glabrous or with few pale hairs; spores very coarsely and irregularly verrucose.

Type: Merrill 6057, Mt Halcon, Mindoro (MICH).

Distr. Tonkin and Kweichow; in *Malaysia*: Sumatra, Sarawak, Philippines (southern Luzon,

Leyte and Mindoro).

Ecol. In forest, to 600 m altitude.

**13. *Lygodium versteegii*** CHRIST, Nova Guinea 8 (1909) 161; v. A. v. R. Bull. Jard. Bot. Btżg II, n. 1 (1911) 10; ? COPEL. Philip. J. Sc. 6 (1911) Bot. 68; ? *ibid.* 11 (1916) Bot. 41; v. A. v. R. Mal. Ferns Suppl. (1917) 118, 499; ALSTON & HOLT. Reinwardtia 5 (1959) 22.—*L. moszkowskii* BRAUSE, Bot. Jahrb. 49 (1912) 57; v. A. v. R. Mal. Ferns Suppl. (1917) 116.—**Fig. 15d-f.**

Rhizome and juvenile fronds not seen. *Rachis* of scandent frond to 2½ mm diameter, minutely hairy (hairs very slender, erect); primary rachis-branches very short, the sunken dormant apex bearing pale hairs; secondary rachis-branches also very short (1–3 mm long), so that the leaflets appear to be verticillate on the main rachis; leaflets 3 or 4 on each side of a dormant apex; sterile leaflets c. 20 cm long, 2–2½ cm wide, entire (margin more or less thickened and cartilaginous), gradually narrowed to the narrow truncate base, sometimes with one or two minute auricles forming separate small lateral leaflets, lamina covered with a close network of conspicuous anastomosing veins, with about 5 rows of areoles between costa and margin (outer areoles progressively smaller), ultimate free veins joining the thickened margin, surface glabrous with scattered warts when dry; fertile leaflets often longer than sterile (to 30 cm long) but narrower, usually reduced to a narrowly winged costa with a row of sorophores on each side, less commonly to a lamina 8 mm wide in which there is slight anastomosis of veins; sorophores 3–4 mm long, contracted at base; indusia more or less hairy; spores coarsely verrucose.

Type: Versteeg 1400, Noord River, W. New Guinea (P, Bo, G, U).

Distr. *Malaysia*: New Guinea.

Ecol. In open places in forest at altitudes up to 1200 m, climbing to a height of 8 m; also reported as an epiphyte in moss on a tall tree.

**14. *Lygodium reticulatum*** SCHKUHR, Farnkr. (1809) 139, t. 139; KUHN in Forschungs. S. M. S. Gazelle 4 Bot., pt 6 (1889) 14; BRAUSE, Bot. Jahrb. 56 (1920) 212.

Similar to *L. microphyllum* in habit and in spores, differing: venation reticulate, lamina firmer, the leaflets usually more elongate.

Distr. Queensland, Fiji to Tahiti, New Hebrides, New Caledonia; reported by KUHN (*l.c.*) from New Ireland but without citation of a specimen, not otherwise known in *Malaysia*.

#### Excluded

*Cheilanthes fuscata* BL. En. Pl. Jav. 2 (1828) 136 = *Mohria caffrorum* (L.) DESV. The type of this plant (L) was identified by ROSENSTOCK and later verified by POSTHUMUS. AS BACKER & POSTHUMUS have pointed out (Varenflora Java p. 144, footnote) various ferns from S. Africa and Macaronesia have been described by BLUME as native in Malaysia, e.g. *Blechnum punctulatum* SW., *Pellaea pteroides* PRANTL, *Cheilanthes hirta* SW., *Ch. multifida* SW., *Asplenium adiantum-nigrum* L., *Hemitelia capensis* R. BR., *Todea barbara* MOORE. Really they had been collected during short stays en route to Java via the Cape of Good Hope and were later mixed up with collections made in Java. It is not improbable that they were collected by KUHL & VAN HASSELT as the herbarium materials collected by these young men and ardent collectors, who unfortunately fell untimely victims of tropical diseases in West Java, came into the hands of BLUME. On the label there is no indication that the specimen originated from the Moluccas, as stated by BLUME.



Fig. 1. *Isoetes habbemensis* ALSTON, tufted in marginal shallows of Habbema Lake, c. 3225 m, with *Libocedrus papuana* F. v. M., on ridge in background (Archbold Expeditions, BRASS, 1938).



## ISOETACEAE (A. H. G. Alston †, London)

### 1. ISOETES

LINNÉ, Sp. Pl. (1753) 1100; Gen. Pl. ed. 5 (1754) 486.—Fig. 1.

Herbaceous, perennial, submerged aquatics or marsh plants, usually with annual grass-like leaves arising in a tuft from a lobed, flattened, corm-like stock. *Stock* divided into stem and rhizophore, 2–4-lobed, with black dichotomous roots arising from the furrows between two lobes. *Roots* monarch, with the stele attached to one side of a central cavity, vascular system protostelic. 2–4-lobed at base. *Leaves* distichous, crowded, with overlapping bases, terete or flattened above, with a broad spoon-like base. Blades with a simple trace and median, unbranched vein, accessory peripheral strands often present; mesophyll chambered with four longitudinal cavities divided by transverse diaphragms, which give the leaf a muriform appearance when seen in transmitted light. Stomata present on one or both surfaces in some species and absent in others. Leaf-bases usually membranaceous and hyaline but in some species persistent as hard, brown, 2-lobed, horny structures. Ligule present near the base of the leaf above the sporangium, arising from a cavity called the ligular pit, cordate-triangular or subulate, 2–15 mm long, without chlorophyll or cuticle, secreting mucilage at least when young. All leaves potentially sporophyll with a sporangium seated in a pit (fovea) on the adaxial surface below the ligule. *Megasporophylls* normally arising below the *microsporophylls*; opening of fovea often wholly or partly covered by a membrane (velum) extending downwards from the apex. *Sporangia* large, 4–7 mm long, oblong, thin-walled (walls with 3–4 layers of cells), subdivided irregularly and incompletely by oblique sterile plates (trabeculae); of two kinds, megasporangia and microsporangia, sessile and broadly adnate. Sporangia with both megaspores and microspores have been reported and the megaspores often vary considerably in size. Megasporangium containing 50–300 trilete spores, 250–900  $\mu$  in diam., white, grey or black, smooth or with warts, spines, or ridges. Microspores monolete, elliptic, 20–45  $\mu$  long, smooth or papillose, 150,000–1,000,000 in each sporangium. Annulus wanting, spores released by the decay of sporangial walls. Some species may be aposporous with young plants taking the place of the developing sporangia. *Gametophytes* dioecious. Female prothallus green, development starting within and the prothallus remaining attached to the wall of the megaspore. Archegonia one or more up to 30, deeply sunken. Rhizoids present, projecting beyond the spore wall. Male gametophyte arising within the microspore, consisting of only a single prothallial cell and an antheridium, with 4 peripheral cells and 4 central cells, each giving rise to a single antherozoid with 15 flagellae.

**Distribution.** About 75 *spp.*, in all parts of the world except the Pacific Islands (present in Tasmania and New Zealand), but mainly temperate, scarce in Asia, in *Malaysia* 3 *spp.*, one in the hills and two in the high mountains.

**Ecology.** The Malaysian species are submerged aquatics in hill and mountain lakes or streams. Outside Malaysia tropical species may also occur in temporary pools, rice-fields, and on damp ground at low altitude. The spores are sometimes dispersed by being carried by detached floating sporophylls; also earthworms have been reported as dispersing both megaspores and microspores in their excreta (DUTHIE, Ann. Bot. 43, 1929, 411–412).

**Morphology and taxonomy.** The most recent comparative survey of the family *Isoetaceae*, regarded as sole family of an order *Isoetales*, is by RAUH & FALK (Sitz. Ber. Heidelb. Ak. Wiss. 1959, I, 1959, 3–160). Three genera are included: *Isoetes* (worldwide), *Stylites* (Peru), and *Nathorstiana* (fossil

of lower Cretaceous, Germany). *Stylites*, with its elongate stem and unbranched roots, shows some resemblances to *Nathorstiana*, which has been considered to be a possible link between *Isoetes* and the Triassic fossil *Pleuromeia*. *Isoetes* has a very short stem of complex structure, and is generally regarded as reduced and specialized. The fossil genus *Isoetites*, differing from *Isoetes* in the relative size of megaspores and microspores, in the shape of leaf-tips and in having an unlobed stem, has been most recently discussed by R. W. BROWN (J. Wash. Acad. Sci. 29, 1939, 261–269) who described two species from N. America, ranging from lower Cretaceous to early Tertiary; he considers that a Portuguese fossil from the lower Cretaceous probably belongs to the same genus, though the specimens are imperfect.

There has been no recent monograph of the whole genus *Isoetes*, and estimates of the number of species vary. C. F. REED has published a very full list of names, with bibliography, in Bol. Soc. Brot. 27 (1953) 5–72.

Cytology. MANTON records chromosome numbers as follows for *Isoetes*: *I. hystrix* DURIEU,  $n = 10$ ; *I. lacustris* L.,  $n = 54-56$  (Problems of Cytology and Evolution in the Pteridophyta, 1950, 254–259). RAUH & FALK (l.c.) record  $2n = c. 50$  for *Stylites gemmifera* W. RAUH.

Uses. Leaves of *I. philippinensis* are said to be eaten.

#### KEY TO THE SPECIES

1. Megaspores smooth on inner surfaces.
  2. Leaves up to 50 cm. Stock 3–4-lobed. Microspores minutely scabrous . . . . . 1. *I. philippinensis*
  2. Leaves up to 14 cm. Stock 2-lobed. Microspores densely spinulose . . . . . 2. *I. habbemensis*
1. Megaspores warted on inner surfaces. Stock 3–4-lobed. Leaves up to 7,5 cm . . . . . 3. *I. neoguineensis*

**1. *Isoetes philippinensis* MERRILL & PERRY**, Am. Fern Journ. 30 (1940) 19, fig.

Submerged aquatic. Stock apparently 3–4-lobed. Leaves numerous, elongate, up to 50 cm, slender, rather flaccid, 3 mm broad in the middle, c. 7 mm broad at base, with membranaceous wings. Accessory peripheral strands wanting. Foveae 3–4 cm long, narrow, 1½–2 mm broad, gradually narrowed upwards, with hyaline margins. Velum none. Ligule elongate, ovate-triangular. *Sporangia* oblong, c. 9 by 3 mm, pale. Megaspores above 420  $\mu$  in diam. with a prominent triradial marking, usually smooth on the inner surfaces, sometimes sparingly and minutely rugose; reticulate on the outer surface. Microspores 25–30 by c. 22  $\mu$ , very minutely scabrous.

Distr. *Malaysia*: Philippines (Mindanao: Lanao Prov. near Momungan, vicinity of Olanu).

Ecol. Bottom of a stream, 400–500 m, once found.

Vern. *Kabauingbauing*, Lanao.

**2. *Isoetes habbemensis* ALSTON**, J. Arn. Arb. 26 (1945) 180.—Fig. 1.

Submerged aquatic. Stock apparently 2-lobed, appressed-semiglobose c. 3½ by 1½ cm across, 1 cm high, with numerous short, brownish-black roots 2 mm in diam. arising from the lower surface. Leaves numerous, up to 14 cm, stout, more or less recurved, c. 3 mm broad in the centre, semicircular in transverse section, rounded on the back and flattened above; central vascular strand rather prominent; margins slightly winged. Upper part of the leaves green, apices caducous. Lower part of leaves c. 3 cm long, pale reddish-brown,

up to 1 cm broad and winged at base. Stomata none. Ligule deltoid. Velum none. *Sporangia* obovate-oblong, c. 1 cm by 4 mm, pale brown. Megaspores c. 575  $\mu$  in diam., almost smooth, with a prominent triradial marking, pale greyish-white when dry. Microspores c. 43  $\mu$  long, densely spinulose, brown when dry.

Distr. *Malaysia*: West New Guinea (Mt Wilhelmina; Lake Habbema), twice found.

Ecol. Abundant in marginal shallows of Lake Habbema and also on Mt Wilhelmina, 3225–3660 m.

**3. *Isoetes neoguineensis* BAKER** [ex F. v. M. Ann. Rep. Brit. N. Guinea 1897–8 (1898) 149, *nomen*]; Kew Bull. (1899) 122; SADEBECK in E. & P. Phl. Fam. 1, 4 (1901) 776; PFEIFFER, Ann. Mo. Bot. Gard. 9(1922) 211.

Submerged aquatic. Stock 3–4-lobed. Leaves numerous, 5–7½ cm by 3 mm, recurved, terete towards the apex, flattened lower down, abruptly dilated at base. Dilated base hyaline, c. 1 cm long and broad. Upper part of leaves dark green. Stomata few. Ligule broadly cordate. Velum none. *Sporangia* oblong, 6 by 4 mm, pale brown. Megaspores c. 800  $\mu$  in diam., deeply and irregularly warted and reticulate on the outer face, warted on the inner faces, with a strongly marked triradial marking.

Distr. *Malaysia*: E. New Guinea (Mts Scratchley and Albert Edward), twice found.

Ecol. Shallows of an alpine lake, 3000–3680 m.

Note. BAKER's statement that the megaspores are smooth between the triradial ridges is incorrect.

## CYATHEACEAE (R. E. Holttum, Kew)

*Caudex* massive, usually erect and unbranched, where prostrate not dorsiventral in structure; fronds arranged on caudex in spiral series; vascular system of caudex a hollow cylinder with gaps corresponding with leaf-bases, in some cases small medullary bundles also present; a cylinder of very hard sclerenchyma, with gaps at leaf-bases, present both inside and outside the vascular cylinder (but absent in *Cibotium*), the surfaces of the sclerenchyma covered with cubical cells containing silica; tangentially arranged sieve-tubes present in the phloem as well as longitudinal ones. *Stipes* of *Cyathea* containing numerous small vascular strands arranged in 3 series (fig. 6), these strands more or less united in smaller axes of *Cyathea*-fronds and also in larger axes of other genera (fig. 31f, 33d); stipe-bases persistent, or sooner or later caducous leaving a pattern of scars on the caudex; pneumathodes present along each side of stipe, in a single discontinuous or almost continuous row, or in 2–3 rows close together, the row joining upwards to a similar row on the basiscopic side of the first pinna, a  $\pm$  circular pneumathode at the base of the pinna beginning the row on the main rachis to the next pinna. *Dermal appendages* on fronds: multiseptate hairs only, or both hairs and scales (*Cyathea*); if both, the hairs often confined to the adaxial surface of the fronds. *Fronds* in most cases bipinnate-tripinnatifid, with varying gradations to tripinnate, in a few cases simply pinnate, in *Culcita* 3–4-pinnate; pinnules almost symmetrical at the base except in *Culcita*; veins normally free except in *Cyathea capitata* and in the genus *Cnemidaria* (trop. America). *Sori* either terminal on veins and protected by an inner indusium as well as by the more or less reflexed edges of a small lobe of the lamina (outer indusium), or apparently not terminal on veins and not near the edge of the lamina, with indusia of various form or without indusia; receptacle of various shape, in all cases containing vascular tissue which in the case of *Cyathea* represents the termination of a short vein; stalks of sporangia short or long, 4 or more cells in transverse section, annulus more or less oblique, with a more or less clearly defined lateral stomium; spores trilete, surfaces smooth or variously sculptured; multiseptate paraphyses, of a single row of cells (terminal cell glandular or not) or scale-like at the base, present with sporangia.

**Distribution.** Throughout the wetter parts of the tropics, especially on mountains; a few species just north of the tropics, more south of the tropics especially in Australasia. As here construed, 9 genera, of which 5 are Malaysian: *Cyathea* (pantropic, at least 600 spp.); *Cnemidaria* (limited to species with simply pinnate fronds, anastomosing veins and distinctive spores, tropical America, 10 spp.); *Lophosoria* (tropical America, monotypic); *Dicksonia* (tropics and southern subtropics in Malaysia, Australasia, America, St Helena, c. 25 spp.); *Cystodium* (Malaysia, monotypic); *Thyrsopteris* (Juan Fernandez, monotypic); *Culcita* (subg. *Culcita* in Azores and tropical America; subg. *Calochlaena* in Malaysia and Australasia; in all c. 7 spp.); *Cibotium* (SE. Asia, Malaysia, Hawaii, Central America, c. 12 spp.); *Metaxya* (tropical S. America, monotypic).

**Fossils.** SEWARD gave a summary of knowledge to 1920 (Fossil Plants 2, 365–375). T. M. HARRIS has recently published a fully illustrated account of some Jurassic frond-fossils which he includes in the family *Dicksoniaceae* (The Yorkshire Jurassic Flora, 1, 1961, 140–181), referring them to the genera *Dicksonia*, *Coniopteris* and *Kylikopteris*. Owing to the fragmentary nature of the fossils it is very difficult to judge how they compare with existing ferns. In my judgement, the fossil most like living *Dicksonia* is *Coniopteris hymenophylloides* (BRONGN.) SEWARD; *C. murrayana* BRONGN. is perhaps more like *Culcita*. The Jurassic fossils most resembling *Cyathea* in form of sterile leaflets are placed in the genus *Kylikopteris*; their fertile leaflets have sori at the ends of veins on a reduced lamina, and seem more like those of *Thyrsopteris* than *Dicksonia*. *Kylikopteris* looks like a possible *Cyathea*-ancestor. Though no fossils with *Cyathea*-like sori have been found in the Yorkshire Jurassic, HARRIS described a genus *Aspidistes* which has sori and sporangia resembling *Dryopteris* or *Thelypteris*, spores trilete (known in a few species of



Fig. 1. *Cyathea gleichemoides* C. CHR. and *C. atrox* C. CHR. growing on steep slopes deforested by fire. Murray Pass, Wharton Range, Central Division, Papua, 2840 m (L. J. BRASS, 1933).



Fig. 2. *Cyathea gleichenioides* C. CHR., same locality as fig. 1. Trunks have been blackened by a recent grass fire (L. J. BRASS).

*Thelypteris* but not in *Dryopteris*) and spherical unicellular glands (common in *Thelypteris*). *Aspidistes* looks like an early *Thelypteris*, and *Thelypteris* has several features in common with *Cyathea*; but one would have expected *Cyathea* to have existed prior to *Thelypteris*. Fossil tree-fern trunks of Lower Cretaceous have also been called *Coniopteris*; they have leaf-scars and vascular system comparable with those of *Cyathea* and *Dicksonia*. OGURA described fossil tree-ferns from Upper Jurassic and Cretaceous rocks of Japan and Korea (J. Fac. Sc. Univ. Tokyo III, 1, 1927, 351–380, pl. 2–8). BANCROFT, describing a fossil Cyatheoid stem from the late Tertiary of East Africa (New Phytol. 31, 1932, 241–253) pointed out that OGURA's fossils differed in some respects from existing *Cyatheaceae*. K. JACOB described impressions of parts of a tree-fern stem from middle Jurassic of NE. India, but the pattern of vascular strands in the leaf-scars is not clearly preserved. He gives references to other descriptions of fossils of presumed Cyatheaceous affinity (Proc. Ind. Ac. Sc. 6, sect. B, 1938, 73–90).

**Ecology.** Most species are forest plants, with varying degrees of tolerance of exposure to direct sunlight and to drying wind. In Western Malaysia *Cyathea moluccana*, *C. squamulata* and *C. glabra* occur only in quite shady forest and will not tolerate exposure; *C. latebrosa* is most vigorous where it has more light and will tolerate almost full exposure of its crown to the sun; *C. contaminans* is only vigorous where its crown is fully exposed, though its roots need shade. It is probably significant that *C. contaminans*, flourishing in clearings in the forest, is more widely distributed than any other Malaysian species. On high mountains in New Guinea a few species (notably *C. macgregorii*) can tolerate the full exposure of open grassland and will tolerate periodic burning of the grass (fig. 1, 2).

**Vegetative morphology.** The majority of species are arborescent, and the habit of growth very similar in all genera. The height to which the trunk will grow varies from species to species; full records of this are not available. The lower part of the trunk has many adventitious roots, which become entangled and form a rigid covering of increasing thickness, supporting the base of the trunk; the cover of roots at the base of an old tree-fern is many times thicker than the original trunk. Some species produce branches, either near the base of the trunk or higher up; in the former case there will be a small cluster of trunks, in the latter the main trunk will have lateral crowns of small leaves upon it (fig. 3–4).

SCHOUTE reported an exceptional case in which 33 such lateral branches on one plant formed many roots which coalesced with those of the main trunk, each lateral branch growing upwards and forming a separate trunk; the result was a cluster of trunks all growing out from one great mass of roots, and the nature of the branching could only be seen by removing the roots (Ann. Jard. Bot. Btzg 20, 1906, 198–207).

SCHOUTE also published a detailed study of four cases in which trunks of tree-ferns appeared to branch by bifurcation, remarking that this condition is rare and may be due to injury (Rec. Trav. Bot. Néerl. 11, 1914, 95–192, t. 5–21). He noted that at each bifurcation is an 'Angularblatt', as in ferns with dichotomously branched rhizomes, and he suggested that perhaps there is no sharp distinction between such bifurcation and lateral branching in which the branch occurs on one side of a leaf-base.

Some species of *Cibotium* and *Culcita*, and also *Cystodium sorbifolium*, have prostrate stems with



Fig. 3. *Cyathea contaminans* (WALL.) COPEL. with branching of upper part of trunk. Mt Telemajo, Central Java (P. ARENS). —Fig. 4. The branched trunk shown in fig. 3 with fronds removed.

indefinite apical growth; these prostrate stems are massive, with leaves close together, never long-creeping which is a distinction from *Dennstaedtia*, a genus united to *Dicksonia* by HOOKER. The indefinite horizontal growth of these stems contrasts with the vertical growth of the arborescent species, which sooner or later outgrow their mechanical strength if they do not earlier succumb to other injuries. *Cyathea biformis* has a very slender trunk which supports itself by adventitious roots clinging to a tree-trunk; its fronds are more widely spaced than in arborescent species.

The diameter of the trunk varies considerably, from the very slender *C. biformis* just mentioned to the massive *C. contaminans* and allied species. The fronds usually break near the base when they are old, their bases persisting for a longer or shorter period; in many cases they are ultimately shed, leaving distinctive scars on the trunk (the scars sometimes later covered by roots). The shape and arrangement of the scars depends on various factors, one being rate of growth of the trunk. A fast-growing trunk will have rather widely spaced frond-scars which are vertically elongated; a slow-growing trunk will have frond-scars closely placed and almost circular (fig. 6). Frond-scars seem always to be in vertical orthostichies, and in several spiral parastichies. SCHOOTE (*l.c.*) described the arrangement of leaf-scars on the branching trunks he examined, and especially the way in which the pattern on the branches is related to that on the parent trunk. In the uniform conditions of the forest of Western Malaysia, new fronds appear singly, but probably they are more abundant following wetter periods. At Tjibodas, West Java, JAAG made observations on seven young plants of *Cyathea contaminans* (*Alsophila glauca*) and found that the average time between development of successive fronds varied from 25 to 28 days, and the life of a single frond from 165 to 200 days; the number of fronds on a single plant varied from 6 to 10, and the time taken for a complete renewal of the whole crown of fronds from 182 to 243 days. An old plant with trunk 10 m tall bore about 12 fronds and the mean time between unfolding of new fronds was 21 days (Mitteil. Naturf. Ges. Schaffhausen 12, 1943, 211–217). It is remarkable that fronds thus ap-



pearing singly leave ultimately the scars of their bases in regular alternate whorls. In New Guinea, HOOGLAND has observed that some species produce their fronds in whorls, those of one whorl being simultaneous. More observations on phyllotaxis and on rate of growth are needed. There is also the consideration that plants of the same species growing under more or less favourable conditions may vary considerably in the size of trunk and of fronds. Few Malaysian species have such massive trunks as the Australian *C. australis* (R. Br.) DOMIN and *Dicksonia antarctica*, which both have fronds in many orthostichies. JAAG observed three plants of *Dicksonia blumei* at Tjibodas. Each crown usually consisted of 16–18 fronds, each new frond appearing at an average interval of 22–27 days, the life of a single frond being 185–191 days.

The pneumathodes which occur along each side of the stipe and rachis often afford distinctive characters in *Cyathea* (fig. 7) but are usually not seen in herbarium specimens, which shrink along the line of thin-walled tissue. In young fronds the pneumathode has a continuous epidermis containing stomata; later the epidermis ruptures and the cells of the underlying tissue become more or less separated from each other, sometimes having peg-like outgrowths.

In shape of frond, shape of leaflets and external form of rachis-branches, *Culcita* and *Thyrsopteris* differ from the other genera. These differences are summarized as follows. *Frond-form*: in *Culcita* and *Thyrsopteris* broadly deltoid, 3–4-pinnate, stipe always long; in other genera elliptical, usually bipinnate-tripinnatifid, lower pinnae always somewhat reduced, sometimes much so and then the stipe very short. *Shape of leaflets*: in *Culcita* and *Thyrsopteris* very asymmetric at base (broad on acroscopic side), with a gradual reduction from largest to smallest; in other genera nearly symmetrical at base, usually with many leaflets (pinnules) on each pinna of approximately equal size. *External form of rachis-branches*: in *Culcita* and *Thyrsopteris* upper surface grooved (fig. 34c), the groove open to admit grooves of smaller branches and of midribs of leaflets (which are similarly grooved), edge of lamina separately decurrent on side of rachis-branch; in other genera upper surfaces raised (or at most slightly grooved), midribs of leaflets also raised (fig. 18b). It may be noted that in all these characters there is more or less complete agreement between *Culcita* and the *Dryopteris*-*Athyrium* group of genera, and between the other genera and the Thelypteroid ferns.

*Dermal appendages*. In *Dicksonia*, *Cystodium*, *Culcita* and *Cibotium* the dermal appendages are all simple septate hairs, the longest often quite thick at the base; the characters of the hairs (rigid or flaccid, long or short, varied colour) especially on the stipe, are always important diagnostically. In *Cyathea* there are always septate hairs (sometimes branched near the base) on the upper (adaxial) surface of stipe and rachises, these hairs rather crisped and antrorse; in most species there are no hairs on the lower surfaces. All species of *Cyathea* have scales on the lower surfaces, in size decreasing from those on the base of the stipe to those on costules of pinnule-lobes. The genus may be divided into two subgenera, *subg. Cyathea* having flabelloid, *subg. Sphaeropteris* setiferous scales (fig. 8). Where hairs occur on lower surfaces in *subg. Sphaeropteris* they are rather thick and straight, much as in *Dicksonia*; in *subg. Cyathea* they are crisped and more or less appressed. For further notes on scales, see *Cyathea*.

*Sori*. In *Dicksonia*, *Cystodium*, *Culcita* and *Cibotium* the sorus is at the end of a vein (or of the acroscopic branch of a vein) near the margin; it is protected by a small reflexed marginal lobe (the outer indusium) and by an inner indusium which shows varying degrees of difference from the outer indusium. The inner indusium is more or less fused to the side of the receptacle remote from the margin (fig. 31b, c). The surface of the receptacle is not very prominent, but spreads at right angles to the end of the vein.

In *Cyathea* the sorus is usually seated at the fork of a vein, well away from the margin; or where the veins are not branched, it is apparently in the middle of a vein. There is always vascular tissue in the receptacle, and this is the end of a short branch-vein. The receptacle is prominent, more or less spherical or clubshaped. The indusium is of very varied form, with also varying degrees of reduction, and is sometimes lacking. The *Cyathea* sorus may be compared to *Dicksonia* by considering the form called *Hemitelia* (fig. 9c), which has an indusium attached to the base of the receptacle on the side remote from the margin (there is never an indusium attached only on the marginal side). The beginning of the development of such a sorus and of a sorus of *Dicksonia* are identical; the receptacle appears to be on the true leaf-margin, with an outgrowth on upper and lower sides. In *Dicksonia* the two outgrowths develop almost equally, in *Cyathea* very unequally so that the sorus is ultimately far from the margin, and new veins are needed to supply the additional marginal area of leaf-lamina. The derivation of the other types of *Cyathea* sorus from this one is described under *Cyathea*.

In *Dennstaedtia*, formerly included in *Dicksonia*, the receptacle is more or less columnar and free, at the end of the vein, and is surrounded by almost completely fused outer and inner indusia; it thus differs from both *Dicksonia* and *Cyathea*.

*Sporangia and spores*. Sporangia are not very large, having in most cases 64 spores. The annulus is in all cases more or less oblique and usually indurated at the base where it passes the stalk. For details, see BOWER, The Ferns 2 (1926) 266, 282, 301 and fig. 5. The stalk is in all cases rather massive, consisting of 4–7 rows of cells. In genera with the *Dicksonia* type of sorus, where the receptacle is not prominent, sporangia have rather long stalks; in *Cyathea* and *Thyrsopteris*, where the receptacle is prominent, sporangia-stalks are short. Spores are in all cases trilete, and the sculpturing of the surface varies considerably, though it is always slight in *Cyathea*. The spores of *Cnemidaria* (confined to *C. horrida* and re-

lated species with simply pinnate fronds and anastomosing veins) have an almost spherical cavity in the thickened lateral walls (alternating with the trilete ridges). This tropical American group have the most distinctive spores in the family, and should rank as a separate genus.

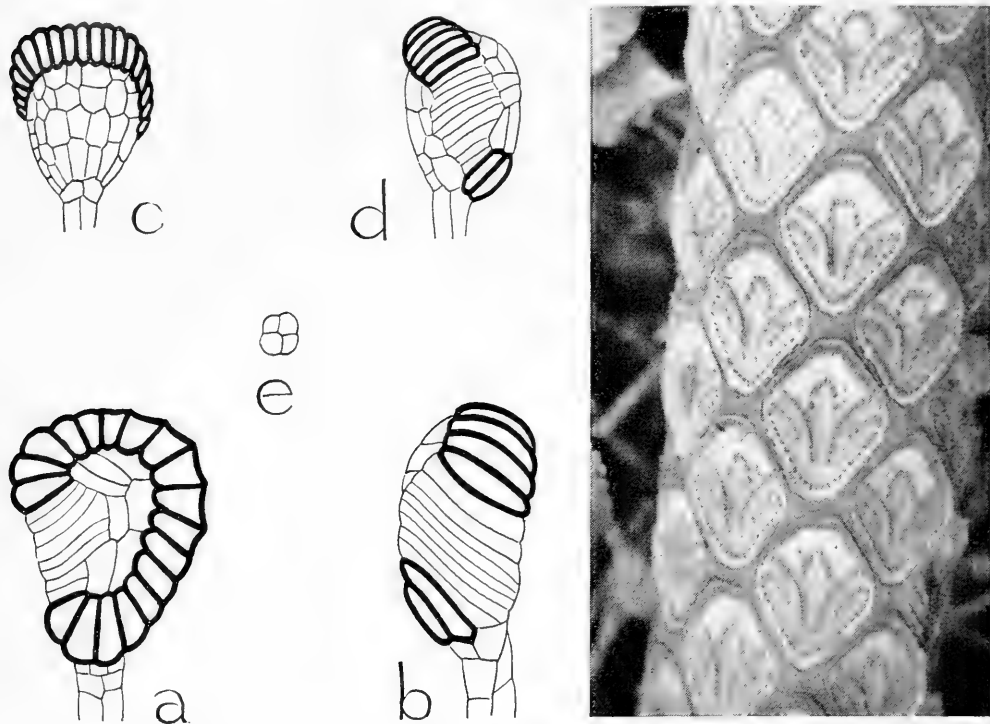


Fig. 5. *Cyathea capensis* (L. f.) SM. a. Sporangium, outer face showing complete annulus and short stalk, b. same, lateral view to show stomium.—*C. brownii* DOMIN (*Alsophila excelsa* R. BR.). c. Sporangium, inner face, d. same, lateral view, e. transverse section of stalk. All  $\times 100$  (after F. O. BOWER, The Ferns, 2, fig. 563).—Fig. 6. *Cyathea contaminans* (WALL.) COPEL. Trunk showing scars after abscission of stipes. Mt Bukit Tungul, W. Java (L. VAN DER PIJL).

**Gametophyte.** STOKEY gave a comparative account of gametophytes of all genera except *Metaxya* and *Cystodium* (Bot. Gaz. 90, 1930, 1–45). Mature prothalli are longer, with more massive cushion, and with greater tendency to fork, than prothalli of the majority of more specialized ferns. Multicellular hairs of peculiar origin occur abundantly in *Cyathea*, rarely and late in *Lophosoria*, not in the other genera. These hairs are in origin like those only of *Gleichenia* and *Loxsonia* (see STOKEY & ATKINSON, *Phytomorphology* 6, 1956, 260); they are longer in *Cyathea* than in *Gleichenia* and lack terminal glandular cells. Antheridia in all cases are relatively primitive, with wall of 5 cells; those of *Thyrsopteris* are largest and least symmetrical. Archegonia have rather long necks, longer in the *Dicksonia* group of genera than in *Cyathea*.

**Cytology.** Chromosome numbers in the genera *Dicksonia*, *Culcita* and *Cibotium* have been recorded by MANTON (J. Linn. Soc. Bot. 56, 1958, 84) and in *Cyathea* by MANTON & SLEDGE (Phil. Trans. R. Soc. B, 238, 1953, 137) and by MANTON (Appendix to HOLTUM, Rev. Fl. Malaya 2, 1954, 623); Prof. MANTON also permits me to report unpublished observations on *Culcita* and Dr T. G. WALKER on *Cnemidaria*. No observations are yet available for *Thyrsopteris*, *Lophosoria*, *Metaxya* and *Cystodium*. The numbers are: *Dicksonia*,  $n = 65$  (3 spp.); *Cibotium*,  $n = 68$  (2 spp.); *Cyathea*,  $n = 69$  (several spp.); *Cnemidaria horrida*,  $n = 69$ ; *Culcita macrocarpa*,  $n = 66$  approx.; *Culcita dubia*,  $n = 58$ .

**Anatomy.** The first critical account of anatomy in this family was by METTENIUS, in the course of his study of *Angiopteris* (Abh. M.-Ph. Kl. K. Sächs. Ges. Wiss. 6, 1863, 525–531, t. V.) The most recent full account of the anatomy of members of *Cyatheaceae* is by OGURA (J. Fac. Sc. Imp. Univ. Tokyo, Bot. 1, 1927, 141–350).

U. SEN has recently completed a new anatomical study of the family, summarized in HOLTUM & SEN



(Phytomorphology 11, 1961, 406–420). The vascular structure, with its accompanying sclerotic tissue, is very similar in all Malaysian genera except *Cibotium*; it is most fully developed in *Cyathea*, to which the following notes apply. As seen in a transverse section of the trunk, there are several meristemes, with gaps between them, together forming a hollow cylinder, the gaps corresponding to leaf-bases. On the outer and inner sides of each meristeme are plates of very hard sclerotic tissue. Small vascular strands arise from the margins of the gaps and supply the leaves, and in *Cyathea* there are also small medullary bundles which anastomose with each other and with the meristemes. Distinctive 'cubical cells' form a more or less continuous layer surrounding each mass of sclerenchyma; their walls adjacent to each other and to the sclerenchyma are much thickened, and they contain crystals which appear to be silica. The sclerotic tissue, with its cubical cells, is lacking in *Cibotium*. In the phloem are tangentially elongated cells, in structure like the longitudinal sieve-tubes; such cells are only otherwise known to occur in *Osmunda*. The pattern of arrangement of the numerous vascular strands in the stipe of *Cyathea* is distinctive; in other genera they are more or less joined. In the smaller axes of the frond the pattern is progressively simplified. The stomata of *Cibotium* show more complex developmental stages than those of the other genera.

**Economic importance.** OCHSE & BAKHUIZEN VAN DEN BRINK reported the use of coiled young fronds of *Cyathea contaminans* and *C. junghuhniana* (mis-named *C. latebrosa*) as food, also the pith of young parts of the trunk of the former species (Vegetables D. E. I., 1931, 212–215). Other species (perhaps all) are similarly edible; HOOGLAND notes this of some from the mountains of New Guinea. The pith of trunks was formerly eaten by Maoris in New Zealand. The common name in Java and Sumatra for the larger tree-ferns, *Pakis* (or *Paku*) *tiang* (*tiyang*, *teehang*), indicates the use of the trunks as posts; this name does not seem to have been noted in the Malay Peninsula. The sclerenchyma of most tree-fern trunks is exceedingly hard and durable, and provides nearly all the mechanical strength when they are used as posts. It also provides an interesting pattern when cut in different ways, and this effect is used in the construction of ornamental objects in various parts of the world. In North Borneo I noted old tree-fern trunks, hollowed out, in use as bee-hives around Dusun houses. On Mt Patuha, W. Java, hollowed tree-fern trunks are filled with carbide gas for making booms on New Year's eve. The masses of adventitious roots at the bases of *Cyathea* trunks are used in orchid culture, either as solid slabs (cut with a saw) or broken, in potting mixtures.

**Taxonomy.** BERNHARDI (in Schrader, Neues J. Bot. 1, ii, 1806, 1–204) attempted a classification of ferns according to the form and position of the annulus of a sporangium, proposing a division into *Helicogyratae* (including *Cyathea* and *Dicksonia*), *Cathetogyratae* (majority of leptosporangiate ferns), *Pseudogyratae* (including *Gleichenia*) and *Agyratae*. PRESL (Tentamen, 1836) varied this by associating *Gleichenia* and *Cyathea* (*sens. lat.*) in *Helicogyratae* and placing *Dicksonia* (under the name *Balantium*) in *Cathetogyratae*. HOOKER (Sp. Fil., 1844 and Syn. Fil., 1868) arranged all ferns in seven suborders, all genera here treated being included in suborder *Polypodiaceae*; they are divided as tribe *Cyatheae* (*Cyathea*, *s.l.*) and tribe *Dicksoniae* (all other genera, also some additional ones). METTENIUS (Fil. Hort. Bot. Lips., 1856) arranged all ferns in eight orders, of which the second was *Cyatheaceae*, which corresponded exactly with the present arrangement with the addition of *Matonia* (METTENIUS used the name *Balantium* in place of *Dicksonia*). CHRIST (Farnkr. d. Erde, 1897), DIELS (in Engl. & Prantl, Pflanzenfam. 1, Abt. 4, 1899, 113–139) and CHRISTENSEN (Ind. Fil., 1905) adopted a family *Cyatheaceae* with the same content as the order *Cyatheaceae* of METTENIUS, with omission of *Matonia*. BOWER, however, believed that *Cyathea* and its near allies should be associated closely with *Gleicheniaceae*, as one of the more primitive elements of the series *Superficiales*, while he placed *Dicksonia* and allies in the series *Marginales*, regarding the separation of the two as 'long overdue' (The Ferns 2, 1926, 326). This idea was followed by CHRISTENSEN in 1938 (in Verdoorn, Man. Pterid., 532, 533), where he recognized two families, *Dicksoniaceae* and *Cyatheaceae*. BOWER's arrangement involves the assumption that primitive *Cyathea*, like *Gleichenia*, was exindusiate, so that indusia in his *Cyatheaceae* are a new development, not homologous with the inner indusium of *Dicksonia* (*l.c.* 304). In this he disagreed with GOEBEL (Flora 105, 1913, 45), who regarded the indusium of *Hemitelia* (now included in *Cyathea*) as strictly homologous with the inner indusium of *Dicksonia*. COPELAND (Gen. Fil., 1947) included *Dicksonia* and allies in a family *Pteridaceae*, associating with them *Lindsaea*, *Dennstaedtia*, etc., while maintaining *Cyathea* *s.l.* in a separate family *Cyatheaceae*. HOLTUM & SEN have published a discussion of the whole question (Phytomorphology 11, 1961, 406–420), with the conclusion that GOEBEL's contention was correct; they give a new subdivision of the family *Cyatheaceae*, as here constituted, based partly on new evidence. This subdivision is summarized as follows.

#### CONSPECTUS OF THE FAMILY

##### Subfamily *Cyatheoideae*.

Fronds normally bipinnate with lower pinnae more or less reduced; pinnules almost symmetrical; upper surfaces of costae and pinna-rachis raised (or, if grooved, the groove of a major axis not open to admit that of a minor one borne upon it); sori terminal on veins or on lower surface of veins, indusiate or not; dermal appendages hairs or scales or both; cubical cells present in association with sclerenchyma; stomata with single subsidiary cell.

Tribe **Cyathea**.

Scales and hairs present as dermal appendages; sori superficial, indusiate or not; cubical cells in continuous layer on surfaces of sclerenchyma.

Fronds mostly bipinnate; veins almost always free; spores with thin walls of uniform thickness, smooth or papillose; indusium various or lacking . . . . . **1. Cyathea**

Fronds simply pinnate with anastomosing veins; spores with wall much thickened, a spherical hollow in the middle of each face; indusium hemitelioid (c. 10 spp., tropical America) (**Cnemidaria**)

Tribe **Lophosorieae**.

Hairs only as dermal appendages; sori superficial, no indusia; cubical cells singly in association with sclerenchyma (1 sp., tropical America) . . . . . (**Lophosoria**)

Tribe **Dicksonieae**.

Hairs only as dermal appendages; sori marginal, protected by slightly modified marginal lobe of lamina (outer indusium) and a thinner inner indusium; receptacle of sorus fused to inner indusium.

Fronds bipinnate with deeply lobed pinnules, or tripinnate; stem usually a thick erect trunk; cubical cells as in *Cyathea* . . . . . **2. Dicksonia**

Fronds bipinnate with simple pinnules; stem prostrate; condition of cubical cells not known.

**3. Cystodium**Subfamily **Thyrsopteridoideae**.

Fronds 3–4-pinnate, lowest pinnae largest; leaflets asymmetric; upper surface of axes and of leaflet-midribs grooved, grooves of major axes open to admit those of minor ones; sori at ends of veins; cubical cells present; stomata with single subsidiary cell.

Tribe **Thyrsopterideae**.

Fertile and sterile parts of frond strongly dimorphous (lamina much reduced in fertile part); receptacle of sorus columnar with sporangia all round it, indusium ultimately a shallow uniform cup; stem massive, erect; cubical cells scattered (1 sp., Juan Fernandez Is.) . . . . . (**Thyrsopteris**)

Tribe **Culciteae**.

Fertile and sterile parts of frond not greatly dimorphous; receptacle of sorus fused to inner indusium (as in *Dicksonia*); inner indusium thinner than outer, the two slightly joined together at the base; stem prostrate or erect; cubical cells in a continuous layer as in *Dicksonia* . . . . . **5. Culcita**

Subfamily **Cibotioideae**.

Fronds normally bipinnate; pinnules almost symmetrical; upper surfaces of pinna-rachises and costae raised; sori terminal on veins, shape much as in *Dicksonia* but with outer and inner indusia both unlike the lamina of the frond, lacking chlorophyll and lacking intercellular spaces; sclerenchyma and cubical cells lacking; stomata with 3 subsidiary cells . . . . . **4. Cibotium**

Subfamily **Metaxyoideae**.

Fronds simply pinnate, pinnae lobed on young plants only; upper surface of rachis and of midribs of pinnae grooved, groove of rachis open to admit grooves of pinna-midribs; sori superficial on lower surface of veins, usually more than one to a vein, no indusium; sclerenchyma and cubical cells lacking; stomata with 3 subsidiary cells (1 sp., tropical America) . . . . . (**Metaxya**)

## ARTIFICIAL KEY TO MALAYSIAN GENERA

1. Upper surface of costae of ultimate leaflets raised; fronds  $\pm$  elliptical, mostly bipinnate.
2. Young parts of plant protected by scales and hairs . . . . . **1. Cyathea**
2. Young parts of plant protected by hairs only.
3. Outer indusium not distinct from rest of lamina.
4. Pinna-rachis raised on upper surface; fertile pinnules deeply lobed. . . . . **2. Dicksonia**
4. Pinna-rachis grooved on upper surface; fertile pinnules not lobed. . . . . **3. Cystodium**
3. Outer indusium quite distinct from lamina of leaflet . . . . . **4. Cibotium**
1. Upper surface of costae of ultimate leaflets grooved, the groove decurrent into the groove of the supporting rachis; fronds deltoid in outline, 3–4-pinnate . . . . . **5. Culcita**

**1. CYATHEA**

SMITH, Mem. Ac. Turin 5 (1793) 416; SWARTZ, Syn. Fil. (1806) 139, 364; KAULF. En. Fil. Chamisso (1824) 254; PRESL, Tent. Pterid. (1836) 54; HOOK. Gen. Fil. (1839) t. 23; Sp. Fil. 1 (1844) 14; Syn. Fil. (1865) 16; J. SMITH, Lond. J. Bot. 1 (1842) 659–668; Hist. Fil. (1875) 244; CHRIST, Farnkr. Erde (1897) 10, 317; DIELS in E. & P. Pfl. Fam. 1, 4 (1899) 123; COPEL. Philip. J. Sc. 3 (1909) Bot. 353; Gen. Fil. (1947) 95.—*Sphaeropteris* BERNH. in Schrader, J. Bot. 1800, ii (1801)

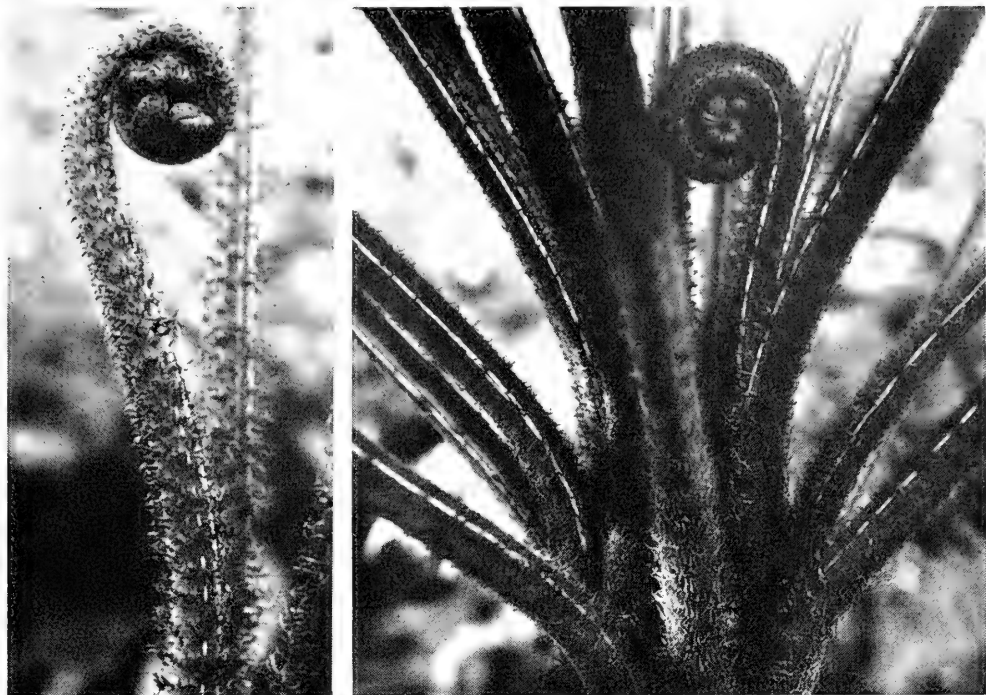


Fig. 7. On left *Cyathea orientalis* (KUNZE) MOORE, young frond showing widely-spaced short pneumathodes. On right *C. incisoserrata* COPEL., bases of stipes showing almost continuous and often double rows of pneumathodes. Cult. R. B. G. Kew (R. VAN CREVEL, 1961).

122.—*Hemitelia* R. BR. Prod. (1810) 158, *p.p.* (excl. *H. horrida*).—*Alsophila* R. BR. *l.c.*—*Chnoophora* KAULF. En. Fil. Chamisso (1824) 250.—*Gymnosphaera* BL. En. Pl. Jav. (1828) 242; COPEL. Gen. Fil. (1947) 98.—*Disphenia* PRESL, Tent. Pterid. (1836) 55.—*Schizocaena* J. SM. in Hook. Gen. Fil. (1838) t. 2; COPEL. Gen. Fil. (1947) 99.—*Amphicosmia* GARDNER, Lond. J. Bot. 1 (1842) 441.—*Dichorexia* PRESL, Abh. K. Böhm. Ges. Wiss. V, 5 (1848) 55.—*Fourniera* BOMMER, Bull. Soc. Bot. France 20 (1873) xix.—*Eatoniopsis* BOMMER, *l.c.*—*Thysanobotrya* v. A. v. R. Bull. Jard. Bot. Btzg II, n. 28 (1918) 66.—**Fig. 1–30.**

*Trunk* always erect, short or tall. *Scales* present on lower (abaxial) and lateral surfaces of axes of frond, at least in early stages of growth, larger ones on stipe and rachis sometimes borne on spine-like outgrowths; *hairs* always on upper surfaces of all but smallest axes, antrorse, sometimes branched; hairs of various kinds sometimes on lower surfaces of axes and veins, rarely on lamina between veins. *Pneumathodes* present in a discontinuous line (or 2–3 lines close together) along each side of stipe and rachis, in *subg. Cyathea* converging downwards on each side of base of stipe and there often deeply excavated at maturity (fig. 7, 12). *Fron*ds  $\pm$  elliptical, lower pinnae always smaller than middle ones, sometimes gradually much reduced and then the stipe short; *pinnae* normally pinnate-bipinnatifid, in a few cases simple, in a few cases fully bipinnate; *pinnules* almost symmetrical at the base, many on each pinna subequal, distal ones more or less abruptly decreasing; upper surface of *pinna-rachis* and costa raised; *veins* simple or branched,

lower ones usually once forked, sometimes pinnate where pinnule-segments are deeply lobed. *Sori* usually at the fork of a vein, or seated on a simple vein, a branch of the vein always entering the receptacle; *indusium* either attached all round base of receptacle and covering young sorus, opening to form a firm-edged cup or opening by irregular rupture, or attached on costular side of receptacle (hemitelioid) and of varying size, in some cases quite hidden by mature sorus, or lacking; *receptacle* erect,  $\pm$  club-shaped to spherical; *sporangia* many, always short-stalked; *paraphyses* usually present as multicellular hairs, sometimes flat and several cells wide at base; in some species of *subg. Sphaeropteris* scales present round base of receptacle, more or less covering young sporangia; *spores* thin-walled, smooth or papillose.

Type-species: *Cyathea arborea* (L.) SM. (tropical America).

Distr. & Ecol. See under the sections.

Morph. *Dermal appendages*. Scales on the stipes of *Cyathea* are of two kinds, and these appear to provide the best subdivision of the genus, at least in Malaysia. The two types of scale are called *flabelloid* and *setiferous* (see HOLTUM, Kew Bull. 1957, 41–45; HOLTUM & SEN, Phytomorphology 11, 1961, 406–420).

*Flabelloid scales* (fig. 8a, b) have a broad median portion consisting of longitudinally elongated cells with all walls thickened, and edges, of varying width, consisting of thin-walled cells diverging fan-wise outwards, with irregularly projecting marginal cells, some of them sometimes thick-walled and dark, often flexuous (fig. 9a, b). The scales develop at the apex of more or less massive (multicellular) outgrowths from the surface of the stipe and at right angles to these outgrowths (thus parallel to the surface of the stipe); the base of a scale is peltate, with a narrow part encircling the supporting outgrowth on the



Fig. 8. *Cyathea oinops* HASSK. a. Scale from costa of pinnule, showing median band of dark thick-walled cells and flabelloid margins of thin-walled cells with a few very thick-walled setae,  $\times 70$ .—*C. incisoserata* COPEL. b. Part of flabelloid margin of scale from stipe,  $\times 100$ .—*C. squamulata* (BL.) COPEL. c. Apical part of scale from costa of a pinnule, showing setiferous (not flabelloid) edge,  $\times 70$ , c'. two very small scales from costa,  $\times 70$ .

basiscopic side. The outgrowths become very large and spine-like in some species, in others they are quite small. As one proceeds from the base of the stipe to the ultimate axes, the scales become progressively smaller, and their character changes in ways characteristic of individual species. These scales provide some of the most important diagnostic characters in *Cyathea*.

*Setiferous scales* (fig. 8c, c') also develop at the apex of outgrowths from the surface of the stipe, but not at right angles to the outgrowths; the base of a scale widens more or less abruptly from the apex of the outgrowth, and in *C. sangirensis* may be seen transitions from stout erect hairs (like those of *Dicksonia*) to setiferous scales. All cells in setiferous scales are longitudinally elongate and all have walls

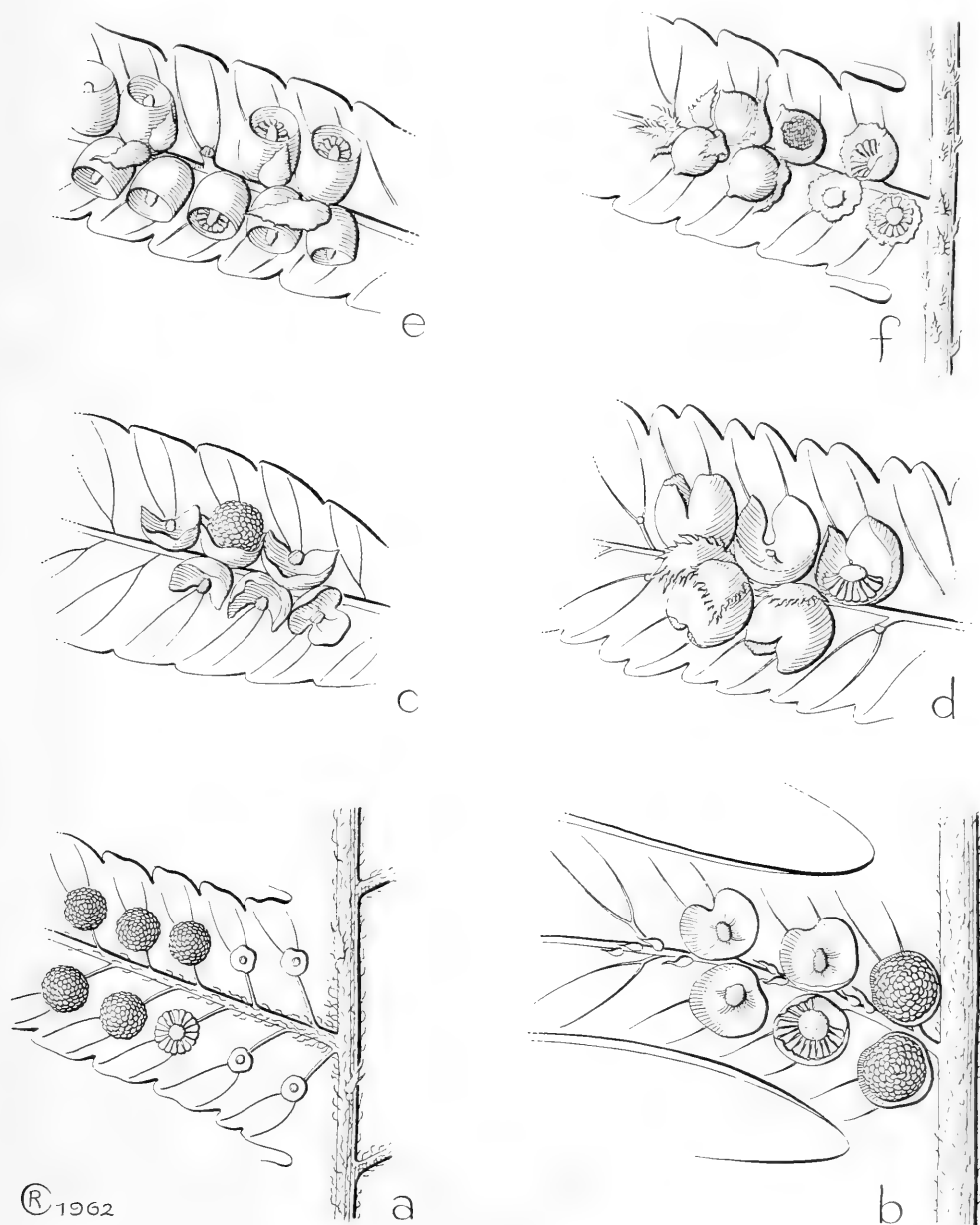


Fig. 9. Different types of indusia in subg. *Cyathea*. *a. C. batjanensis* (CHRIST) COPEL.; indusium a small disc covered by mature sori.—*b. C. javanica* BL.; indusium saucer-shaped, often asymmetric.—*c. C. heterochlamydea* COPEL.; indusium attached on costular side of receptacle, covering part of base of mature sori.—*d. C. oinops* HASSK.; indusium covering sori almost to maturity, but open on side remote from costule (two indusia cut to show receptacle, costular scales also shown).—*e. C. orientalis* (KUNZE) MOORE; indusium a complete rather deep cup.—*f. C. crenulata* BL.; indusium very fragile, covering sori completely to maturity, then breaking irregularly and in part disappearing (*a*,  $\times 6$ ; *b-f*,  $\times 10$ ; *a* DE VRIESE 323, *c* ELMER 11634, *d* MATTHEW *s.n.*, *e* KOORDERS 37469, *f* MEIJER 119).

of equal thickness (they are rarely so thick as in flabelloid scales); some marginal cells grow obliquely outwards at their distal ends to form straight or outcurved rigid, usually dark, setae on the edge of the scale (fig. 8a).

**Taxon.** Early authors attempted to distinguish genera (within the genus *Cyathea* as here recognized) by characters of the indusium, whether cup-shaped, attached to one side of the receptacle, or absent. These three conditions do not cover all cases, and indusia have often been inadequately described. Species lacking indusia often resemble indusiate species more closely than other exindusiate ones. It thus appears that the exindusiate condition has arisen on more than one evolutionary line, and it does not give a natural subdivision of the genus. PRESL attempted also to distinguish species in which the receptacle splits into two halves (*Disphenia*, *Dichorexia*), but this is not a significant characters.

COPELAND at first united all Malaysian species in the genus *Cyathea* (Philip. J. Sc., Bot. 3, 1909, 353; 4, 1909, 28) but later attempted to distinguish the three genera *Cyathea*, *Gymnosphaera* and *Schizocaena* (Gen. Fil. 1947, 94-99), a division which I criticized (Kew Bull. 1957, 41-45). Most of the species of COPELAND's *Gymnosphaera* sect. 3 appear to be closely related to the type species of *Schizocaena*. Eliminating these, I have found it extremely difficult to make a clear-cut separation between *Gymnosphaera* and some species included by COPELAND in *Cyathea*. COPELAND's *Cyathea* is divisible, on the basis of scale-characters (see above) into two groups which I call *subg. Cyathea* (flabelloid scales) and *subg. Sphaeropteris* (setiferous scales). *Gymnosphaera* (excluded COPELAND's sect. 3) is then a section of *subg. Cyathea*, and *Schizocaena* a section of *subg. Sphaeropteris*.

In *Cyathea subg. Cyathea* all possible conditions of the indusium occur, and it appears that species with cup-shaped indusia can be closely related to others with hemitelioid indusia; in some species, e.g. *C. javanica* BL. (fig. 9b) and *C. hymenodes* METT., intermediate conditions may occur on the same leaflet as typical indusia. Some species have very large hemitelioid indusia which cover the sorus almost to maturity, often breaking later (*C. loheri* CHRIST, *C. oinops* HASSK., fig. 9d); these have usually not been distinguished from species in which the indusium is at first quite complete (e.g. *C. crenulata* BL., fig. 9f). Other species show various stages of reduction of the hemitelioid type of indusium; in many cases this is quite hidden by the mature sorus (fig. 18) and has been reported as lacking (the species thus being placed in *Alsophila*). In *subg. Sphaeropteris* the hemitelioid condition has not been found. Most species of this subgenus have a complete indusium, breaking at maturity (never truly cup-shaped) or none; two cases where partial indusia occur (*C. alternans* (WALL.) PR. and *C. discophora* HOLTUM) appear to be intermediate between fully exindusiate and exindusiate species and are probably hybrids.

Descriptions of species of *Cyathea* have rarely been satisfactory, and misidentifications have been frequent; hence names in collectors' lists, and distribution data based on them, are often unreliable. For clear distinction between species, detailed descriptions of scales, hairs and indusia are essential, and often these cannot be seen satisfactorily with a  $\times 10$  lens. The only authors who described such details adequately were METTENIUS and CHRISTENSEN. Because of inadequate early descriptions, many species have been named more than once, and the only way to know this is to examine type material. I have seen such material of almost all the 350 species described from Malaysia, and have examined also types of species from the mainland of Asia and from the Pacific.

#### SUBDIVISION OF THE GENUS CYATHEA

1. Stipe-scales flabelloid; hairs on lower surfaces, if present, crisped and appressed; pinnules in most cases deeply lobed, basal basiscopic vein rarely from costa; indusia in some cases hemitelioid.

##### SUBG. CYATHEA.

2. Indusiate (indusia in some cases very small) or if exindusiate hairy on lower surface of pinna-rachis; axes not very dark; little dimorphism between sterile and fertile pinnules. *Spp.* 1-103.

##### 1. Sect. *Cyathea*

2. Exindusiate; axes very dark, not hairy beneath; fertile and sterile pinnules usually very dimorphous. *Spp.* 104-120

1. Stipe-scales setiferous; hairs on lower surfaces, if present, rather thick and spreading; where pinnules are shallowly lobed, basiscopic vein always from costa; indusia complete, or lacking, or formed of separate scales (in a few cases imperfect, and then not hemitelioid).

##### SUBG. SPHAEROPTERIS.

3. Costules not widely spaced (rarely over 4 mm apart in pinnules 10 cm long); pinnules usually 10 cm or more long, lobed almost or quite to costa throughout, or fully pinnate. *Spp.* 121-151.

##### 3. Sect. *Sphaeropteris*

4. Free tertiary leaflets few; indusia present or absent; sori never covered with overlapping scales. *Spp.* 121-143

##### 3a. Subsect. *Sphaeropteris*

4. Free tertiary leaflets many; no indusia; sori covered with overlapping scales. *Spp.* 144-151.

##### 3b. Subsect. *Fourniera*

3. Costules widely spaced (at least 4 mm apart except where pinnules are under 4 cm long); pinnules mostly less than 10 cm long, not lobed to within 1 mm of costa except near base; basal basiscopic vein always from costa; indusiate or not. *Spp.* 152-191.

##### 4. Sect. *Schizocaena*

5. Scales of stipe 1 cell thick throughout. *Spp.* 152-178

##### 4a. Subsect. *Schizocaena*

5. Scales of stipe thick and fleshy at base, tapering and flat distally (fig. 30). *Spp.* 179-191.

##### 4b. Subsect. *Sacropholis*

Subgenus *Cyathea*1. Section *Cyathea*

Distr. Pantropic.—Fig. 1–2, 7–18.

Taxon. This is by far the largest subdivision of the genus, and includes species with all forms of indusia and with none. I have not been able to distinguish sharply defined groups which could appear as main divisions of the key. The main key-characters are based on indusia, and allied species are sometimes separated by this method. The species with hemitelioid indusia are the most difficult to characterize clearly; this group is particularly polymorphic in Sumatra and in the Philippines. There may be hybrids, but the remarkably uniform characters of *C. latebrosa* (WALL.) COPEL., a common species in Malaya of which I have seen a large number of specimens, indicates that quite small differences can be constant. Size of pinnules is not a reliable character, unless one can see ample material; plants growing in exposed conditions may have much smaller pinnules than others of the same species in the shade. However, the very large pinnules of *C. incisoserrata* COPEL., otherwise very near *C. latebrosa*, appear to be constant, and are exactly reproduced in new plants raised from spores at Kew. For local floras it will probably be possible to devise keys based on macroscopic characters easily observed in the field; in preparing keys to cover all Malaysian species, I have not been able to use such characters.

I am not sure whether the hemitelioid species of tropical America should be placed in this section, or in a separate section; if the latter, the name *Hemitelia* is available for them (type-species *H. multiflora* (SM.) R. BR.). Some exindusiate tropical American species appear distinct in their dermal appendages. These have been referred to *Alsophila*, but do not appear to be nearly related to the type-species of *Alsophila*, *A. australis* R. BR.; they need further study.

Ecol. All species, except those of very high altitudes, are more or less shade-demanding.

## KEY TO THE SPECIES

1. Pinnules not over 30 mm long; segments mostly constricted at base or the lower ones quite free.
  2. Lower surface of pinna-rachis bearing crisped hairs.
    3. Sori lacking indusia . . . . . 1. *C. lepidoclada*
    3. Sori indusiate; indusium cup-shaped.
      4. Bullate scales present on pinna-rachis and/or costae; stipe-scales to 2 mm wide.
        5. Pinnules to c. 30 mm long . . . . . 2. *C. microphyloides*
        5. Pinnules to c. 15 mm long . . . . . 3. *C. perpalligera*
      4. Bullate scales lacking from pinna-rachis and/or costae; stipe-scales to 3½ mm wide.
        4. *C. hunsteiniana*
  2. Lower surface of pinna-rachis not hairy.
    6. Longest pinna 8½ cm, pinnules to 11 mm long . . . . . 5. *C. arfakensis*
    6. Longest pinna 22–26 cm, pinnules 23–30 mm long.
      7. Stipe 30 cm. Pinna-rachis glabrescent. Sori 4–5 to each tertiary leaflet . . . . . 6. *C. ledermannii*
      7. Stipe 10 cm. Pinna-rachis covered with small bullate scales. One sorus at base of each tertiary leaflet . . . . . 7. *C. hooglandii*
1. Pinnules longer, or if under 30 mm long without free basal segments.
  8. Indusium an entire cup with even edge at maturity of sorus, if fragile sometimes breaking later.
    9. Lower surface of lamina-segments almost or quite covered with scales and hairs.
      10. Small scales abundant on lower surface of veins; costal scales mostly bearing dark setae.
        8. *C. percrassa*
      10. Crisped hairs on lower surface of veins; costal scales bearing many slender crisped marginal hairs.
        9. *C. vandeusenii*
    9. Lower surface of lamina-segments not so covered.
      11. Lower surface of lamina strongly glaucous . . . . . 10. *C. pruinosa*
      11. Lower surface of lamina not glaucous.
        12. Bullate-based scales present on pinna-rachis and/or costae.
          13. No fine crisped hairs on lower surface of pinna-rachis nor on edges of its scales.
            11. *C. pycnoneura*
          13. Fine crisped hairs present on pinna-rachis or on its scales.
            14. Indusial cup shallow. Small scales on pinna-rachis bearing very fine hairs; no coarse crisped hairs; bullate scales only on distal part of pinna-rachis . . . . . 12. *C. rigens*
            14. Indusial cup deep. Crisped hairs, not small fringed scales, also bullate scales, present on pinna-rachis . . . . . 13. *C. everta*
      12. Bullate-based scales lacking on pinna-rachis and/or costae (at most convex ovate brown scales on costa).
        15. Lower surface of pinna-rachis covered with crisped hairs . . . . . 14. *C. cincinnata*
        15. Lower surface of pinna-rachis lacking such hairs.
          16. Pinna-rachis almost glabrescent on lower surface.
            17. Larger pinnules bearing c. 6 pairs of free tertiary leaflets . . . . . 15. *C. subtripinnata*

17. Larger pinnules bearing at most one pair of free leaflets.
18. Pinnules commonly to 100 mm long, basal lobes not free. Long brown scales lacking on costae . . . . . **16. *C. orientalis***
18. Pinnules commonly to 65 mm long, basal pair of lobes free. Long dark scales abundant on costae . . . . . **17. *C. apoensis***
16. Pinna-rachis persistently scaly on lower surface.
19. Scales on pinna-rachis mostly narrow, 4–5 mm long, with long flexuous marginal setae. Stipe over 20 cm . . . . . **18. *C. costalisora***
19. Scales on pinna-rachis mostly very small, some or all bearing short setae. Stipe c. 10 cm.
20. Scales on pinna-rachis dark, all setiferous. . . . . **19. *C. pallidipaleata***
20. Scales on pinna-rachis thin, short-fringed, mostly not setiferous, forming a continuous felt. . . . . **20. *C. coactilis***
8. Indusium otherwise or lacking.
21. Indusium at maturity an almost flat disc, symmetric or not, in some cases hidden by mature sorus, in some cases the residual part of a complete indusium of which the thin apical parts falls away at maturity.
22. Indusium a very narrow ring round base of receptacle.
23. On lower surface of pinna-rachis and costae very small scales bearing long crisped hairs, or single crisped hairs.
24. Scales on costae bullate-based to bullate . . . . . **21. *C. parva***
24. Scales on costae flat or lacking, not bullate.
25. Broad flat pale scales with a few marginal setae on costae . . . . . **22. *C. wengiensi***
25. Broad flat setiferous scales lacking on costae. . . . . **23. *C. batjanensis***
23. On lower surface of pinna-rachis small scales with short fringe of hairs. **24. *C. ternatea***
22. Indusium ultimately a regular or irregular disc, almost or quite as big as base of sorus; if irregular, usually the base of a formerly complete indusium.
26. Indusium at maturity a disc with fairly even edge (except in *C. patellifera*).
27. Pinna-rachis hairy on lower surface, at least distally.
28. Pinna-rachis bearing copious bullate-based scales on lower surface . . . . . **25. *C. albidosquamata***
28. Pinna-rachis lacking such scales.
29. Pinnules to at least 85 by 20 mm, veins 8–10 pairs.
30. Pinna-rachis and costae densely hairy on lower surface; costae glabrous or nearly so on upper surface . . . . . **26. *C. javanica***
30. Pinna-rachis hairy towards apex only; costae with few hairs on lower surface, many on upper surface . . . . . **27. *C. hymenodes***
29. Pinnules c. 30–70 by 12–15 mm, veins 4–6 pairs.
31. Lower 3–4 pairs of segments on each pinnule free and deeply lobed. Indusium irregularly lobed . . . . . **28. *C. patellifera***
31. Lowest segments not free, crenate. Indusium an entire disc. . . . . **25. *C. albidosquamata***
27. Pinna-rachis not hairy on lower surface.
32. Distal part of pinna-rachis covered with scales.
33. Lowest pinna c. 6 cm long, stipe short . . . . . **29. *C. negrosiana***
33. Lowest pinna much longer, stipe not very short.
34. Scales on stipe dark; scales on pinna-rachis bullate . . . . . **30. *C. catillifera***
34. Scales on stipe pale; scales on pinna-rachis not bullate, larger ones having marginal setae. . . . . **31. *C. horridula***
32. Distal part of pinna-rachis glabrescent, never covered with bullate scales. **43. *C. bunnemeijerii***
26. Indusium at first covering sorus, apical part very thin and caducous, an irregular disc remaining on old sorus.
35. Pinna-rachis hairy on lower surface, at least distally.
36. Pinnules c. 50 by 15 mm, pinnae to 21 cm long . . . . . **32. *C. tenuicaulis***
36. Pinnules to 95 by 18 mm, pinnae to 50 cm long . . . . . **33. *C. sumatrana***
35. Pinna-rachis not hairy on lower surface.
37. Frond simply pinnate, pinnae to 7 by 1¾ cm, lobed to 2 mm from costa. **34. *C. klossii***
37. Frond bipinnate.
38. Small pale fringed scales abundant at least on costae.
39. Spines on stipe 2–3 mm long; rachises ± covered beneath with small fringed scales as on costae . . . . . **35. *C. trachypoda***
39. Spines on stipe less than 1 mm long; rachises not so covered . . . . . **36. *C. crenulata***
38. Small pale fringed scales lacking or very few.
40. Stipe bearing spines 3–5 mm long.
41. Larger scales on costae bearing dark setae. . . . . **37. *C. macropoda***
41. Larger scales on costae not bearing dark setae.
42. Small scales on costae bearing long crisped hairs . . . . . **38. *C. saccata***
42. Small scales on costae lacking such hairs.



43. Largest pinnules 150–175 by 30–40 mm . . . . . 39. *C. magnifolia*  
 43. Largest pinnules c. 90 by 18 mm . . . . . 40. *C. acanthophora*  
 40. Stipe not spiny, or spines under 1 mm long.  
 44. Stipe-scales less than 1 mm wide above the base, edges when young setiferous; abundant narrow scales bearing long setae on pinna-rachis . . . . . 41. *C. rubiginosa*  
 44. Stipe-scales otherwise; pinna-rachis scales rarely setiferous.  
 45. Stipe densely scaly throughout . . . . . 42. *C. apiculata*  
 45. Stipe persistently scaly near base only.  
 46. Stipe long; lowest pinnae not greatly reduced.  
 47. Stipe dark, scales firm, shining; bullate scales abundant on costules.  
 43. *C. bunnemeijerii*  
 47. Stipe green, scales thin, dull; no bullate scales on costules . . . 44. *C. excavata*  
 46. Stipe short; lowest pinnae c. 5 cm long . . . . . 45. *C. christii*  
 21. Indusium otherwise or lacking.  
 48. Indusium covering sorus to maturity, then breaking and persistent.  
 49. Pinna-rachis conspicuously hairy and scaly on lower surface . . . . 46. *C. geluensis*  
 49. Pinna-rachis not hairy, though sometimes scaly on lower surface.  
 50. Lamina very rigid, the small tertiary leaflets with edges much reflexed so that the sori are almost enclosed.  
 51. Largest tertiary leaflets lobed, each with 3–5 sori. . . . . 47. *C. macgregorii*  
 51. Tertiary leaflets not lobed, each with 1–2 sori . . . . . 48. *C. gleichenioides*  
 50. Lamina not very rigid with strongly reflexed edges.  
 52. Pinnules to 2½ cm long, less than 10 mm wide.  
 53. Pinna-rachis and costae persistently brown-scaly; scales entire, smaller ones bullate.  
 49. *C. havilandii*  
 53. Pinna-rachis and costae glabrescent; scales small, not bullate . . 50. *C. imbricata*  
 52. Pinnules to at least 45 by 10 mm, in most cases much larger.  
 54. Largest pinnules more than 100 by 20 mm; costules 5 mm or more apart.  
 55. Bullate scales present on costules. Pinnules distinctly stalked; several pairs of free segments on larger pinnules.  
 56. Stipe long, slender, very spiny. Pinnules commonly with stalks 3–6 mm long, to 10 mm on lowest . . . . . 51. *C. longipes*  
 56. Stipe not known. Pinnule-stalks not over 4 mm . . . . . 52. *C. acuminata*  
 55. Bullate scales lacking on costules. Pinnules sessile or on stalks to 2 mm; at most 1–2 pairs of free segments . . . . . 53. *C. insulana*  
 54. Largest pinnules not over 100 by 20 mm; costules 3–4½ mm apart.  
 57. Pinnules c. 45 by 10 mm, very rigid. Stipe-scales rigid, 40 by 1 mm.  
 54. *C. pseudomuelleri*  
 57. Pinnules commonly more than 65 by 15 mm. Stipe-scales otherwise.  
 58. Costae and costules densely scaly; scales mostly setiferous, not bullate; pinna-rachis persistently covered with very small setiferous scales.  
 59. Veins bearing scales on lower surface.  
 60. Stipe 50 cm or more . . . . . 55. *C. archboldii*  
 60. Stipe 5–15 cm, lowest pinna 5–12 cm.  
 61. Larger scales on pinna-rachis pale. Veins dark and raised on lower surface.  
 56. *C. foersteri*  
 61. Larger scales on pinna-rachis with dark median band. Veins concolorous, not raised below . . . . . 57. *C. nigrolineata*  
 59. Veins lacking scales on lower surface.  
 62. Large scales on stipe and rachis light red-brown. . . . . 58. *C. inquinans*  
 62. Large scales not red-brown.  
 63. Larger scales on pinna-rachis pale . . . . . 56. *C. foersteri*  
 63. Larger scales on pinna-rachis with dark median band. . . . . 57. *C. nigrolineata*  
 58. Costae and costules bearing scales which are mostly not setiferous; pinna-rachis glabrescent or its scales mostly not setiferous.  
 64. Stipe-scales pale; pinna-rachis rather persistently covered with small scales beneath; veins bearing some scales . . . . . 56. *C. foersteri*  
 64. Stipe-scales dark; pinna-rachis glabrescent; veins not scaly.  
 65. Costae and/or costules bearing bullate scales.  
 66. Pinnules at base of larger pinnae distinctly stalked (stalks 2–4 mm; costules 4–4½ mm apart . . . . . 59. *C. ferruginea*  
 66. Pinnules sessile; costules usually not over 3½ mm apart.  
 67. Indusium firm, brown . . . . . 60. *C. oosora*  
 67. Indusium pale, fragile . . . . . 45. *C. christii*  
 65. Costae and/or costules lacking bullate scales . . . . . 61. *C. halconensis*

48. Indusium hemitelioid (sometimes almost covering sorus to maturity, sometimes very small) or lacking.
68. Indusium lacking.
69. Fronds simply pinnate, or bipinnate with small pinnules lobed halfway to costa.
70. Fronds simply pinnate . . . . . 62. *C. ascendens*
70. Fronds bipinnate, pinnules c. 30 mm long . . . . . 63. *C. recurvata*
69. Fronds bipinnate, pinnules more deeply lobed.
71. Pinna-rachis densely covered with long tangled pale crisped hairs and narrow scales on lower surface . . . . . 64. *C. eriophora*
71. Pinna-rachis rather sparsely hairy on lower surface.
72. Sori near costules. Dark hairs present on costae beneath . . . . . 65. *C. gregaria*
72. Sori medial or nearly so. No dark hairs on costae beneath. See *sect. Gymnosphaera*.  
116. *C. macgillivrayi*
68. Indusium hemitelioid, of varying size, sometimes hidden by sorus.
73. Pinna-rachis densely hairy throughout on lower surface.
74. Bullate scales abundant on costae.
75. Raised median part of upper surface of pinna-rachis and costae hairy 66. *C. modesta*
75. Raised median part of upper surface of pinna-rachis and costae glabrous.  
67. *C. doctersii*
74. Bullate scales absent, or a few distally on costae.
76. Pinnules to 40 by 10 mm. Scales on costae setiferous . . . . . 68. *C. cucullifera*
76. Pinnules much larger. Scales on costae not setiferous . . . . . 69. *C. setulosa*
73. Pinna-rachis hairy at most on distal part.
77. Indusium entirely brown and rather firm, quite covering sorus to maturity, breaking only when old.
78. Stipe-scales 50 mm long, shining brown. Costae almost glabrous. Pinnules c. 50 mm long.  
70. *C. muelleri*
78. Stipe-scales 20–35 mm long, pale. Costae very scaly. Pinnules to 100 mm long.
79. Larger scales on costae uniformly brown, rather thin, edges with some setae.
80. Bullate scales lacking. Lower pinnae not gradually reduced (sometimes a pair 5 cm long near base of stipe) . . . . . 71. *C. oinops*
80. Bullate scales on costules. Lower pinnae gradually reduced to 7 cm long.
81. Pinna-rachis densely covered with overlapping scales. Indusium firm, shining. 72. *C. loheri*
81. Pinna-rachis sparsely covered with very small pale fringed scales. Indusium dull, thinner.  
73. *C. cinerea*
79. Larger scales on costae with narrow very dark median band and broad pale edges, or entirely pale . . . . . 74. *C. pachyrrhachis*
77. Indusium in part pale and fragile, breaking at maturity, or not entirely covering sorus.
82. Pinnules 20–40 mm wide; costules 5–6 mm apart; lowest basisopic vein from costa or base of costule . . . . . 75. *C. latipinnula*
82. Pinnules rarely over 2 cm wide; costules not over 5 mm apart; basisopic vein always from costule.
83. Indusium visible as a scale backing the costule, not entirely hidden by sorus.
84. Pinnules conspicuously stalked; stalks to 7 mm long.
85. Stipe bearing spines 3–4 mm long. No bullate scales on costules.  
76. *C. masapilidensis*
85. Stipe not spiny. Bullate scales present on costules. . . . . 77. *C. loerzingii*
84. Pinnules not conspicuously stalked.
86. Indusium more than a semicircle, concave towards sorus and sometimes covering part of sorus to maturity.
87. Pinna-rachis densely and persistently scaly. . . . . 78. *C. rufopannosa*
87. Pinna-rachis not densely and persistently scaly.
88. Indusium fragile, breaking and often in part disappearing. . . . . 79. *C. callosa*
88. Indusium firm throughout.
89. Frond almost fully tripinnate; tertiary leaflets with strongly reflexed edges.  
80. *C. dicksonioides*
89. Frond bipinnate with at most 1–2 pairs of tertiary leaflets; edges of segments not strongly reflexed.
90. Pinnules c. 100 mm long. Segments of lamina mostly not constricted at base on acroscopic side; bullate or convex pale scales on costules 81. *C. heterochlamydea*
90. Pinnules c. 60 mm long. Segments of lamina mostly constricted at base on acroscopic side; no bullate scales . . . . . 82. *C. edanoi*
86. Indusium not more than a semicircle, reflexed against costule at maturity.
91. Bullate scales abundant and rather persistent on pinna-rachis (at least distally); pinna-rachis closely and finely warty after fall of scales.

92. Stipe-scales dark with thin pale edges. Basal 1-2 segments of pinnules almost free. 83. *C. fuliginosa*
92. Stipe-scales (at least larger ones) pale. Basal 6 pairs of segments almost free, separately adnate to costa . . . . . 84. *C. semiamplectens*
91. Bullate scales lacking on pinna-rachis.
93. Basal scales on costae bearing some marginal setae.
94. Bullate scales abundant on costules. Stipe long, basal pinnae not much reduced.
95. Costules  $4\frac{1}{2}$ - $5\frac{1}{2}$  mm apart. Pinnules 100 mm or more long. 85. *C. alleniae*
95. Costules 3- $4\frac{1}{2}$  mm apart. Pinnules to 60 mm long. . . . . 86. *C. costulisora*
94. Bullate scales absent. Stipe short, basal pinnae gradually reduced, lowest very short. 87. *C. caudata*
93. Basal scales on costae without setae.
96. Bullate scales present (if at all) towards apex of costa; costal scales few. Pinnules to 100 mm long.
97. Scales on costules distinctly bullate; pinna-rachis slightly hairy towards apex on lower surface . . . . . 88. *C. borneensis*
97. Scales on costules mostly flat or convex, or distal ones bullate; pinna-rachis not hairy on lower surface.
98. 1-2 pairs basal segments on larger pinnules almost or quite free. 89. *C. fenicis*
98. Basal segments not free . . . . . 90. *C. junghuhniana*
96. Bullate scales abundant to base of costae and on costules. Pinnules to 65 mm long. 91. *C. raciborskii*
83. Indusium very small, hidden by sporangia.
99. Pinnules commonly more than 20 mm wide.
100. Pinnules cut to 3-4 mm from costa . . . . . 92. *C. glaberrima*
100. Pinnules cut almost to costa throughout.
101. Lower pinnules distinctly stalked. Sinuses between segments narrow. 93. *C. punctulata*
101. Lower pinnules sessile or nearly so. Sinuses between segments wide. 94. *C. incisoserrata*
99. Pinnules commonly not more than 20 mm wide.
102. Pinna-rachis densely covered with bullate scales; pinnules c. 32 by 10 mm. 95. *C. physolepidota*
102. Pinna-rachis not so covered; pinnules larger.
103. Scales on costae and costules all flat.
104. Lower pinnules stalked. No hairs on pinna-rachis and costae.
105. Lowest 1-2 pairs of segments quite free and articulate. Lamina thick, rigid. 96. *C. kanehirae*
105. Lower segments, several pairs, contracted at base but not free. Lamina not thick. 97. *C. nigropaleata*
104. Lower pinnules sessile. Hairs present on pinnae-rachis and costae.
106. Sori near costules (Luzon) . . . . . 98. *C. microchlamys*
106. Sori medial (New Guinea) . . . . . 22. *C. wengiensis*
103. Scales on costules bullate; some bullate scales often on costae.
107. Pinnules articulate to pinna-rachis. . . . . 99. *C. perpunctulata*
107. Pinnules not articulate.
108. Paraphyses conspicuous, longer than sporangia, 2-3 cells wide at base.
109. Stipe-spines 3-4 mm long. Pinna-rachis hairy towards apex on lower surface. 100. *C. alderwereltii*
109. Stipe-spines 1- $2\frac{1}{2}$  mm long. Pinna-rachis not hairy on lower surface.
110. Lamina-segments strongly crenate-serrate. Indusium minute. Bullate scales throughout costae.
111. Stipe over 50 cm; lowest pinnae little reduced. . . . . 101. *C. amboinensis*
111. Stipe 20-25 cm; lowest pinna 8-12 cm long. . . . . 102. *C. media*
110. Lamina segments shallowly crenate. Indusium distinct, 2-lobed; bullate scales only on distal part of costa . . . . . 103. *C. latebrosa*
108. Paraphyses shorter than sporangia, slender.
112. Pinna-rachis hairy towards apex on lower surface. Lower pinnae much reduced and spaced . . . . . 88. *C. borneensis*
112. Pinna-rachis not hairy on lower surface. Lower pinnae not greatly reduced.
113. One to two pairs of basal segments on larger pinnules almost or quite free. 89. *C. fenicis*
113. No free segments at base of pinnules.
114. Stipe-thorns 5 mm or more long. . . . . 40. *C. acanthophora*
114. Stipe-thorns to  $2\frac{1}{2}$  mm long. . . . . 90. *C. junghuhniana*

1. *Cyathea lepidoclada* (CHRIST) DOMIN, Acta Bot. Bohem. 9 (1930) 130; C. CHR. Brittonia 2 (1937) 278; COPEL. Philip. J. Sc. 77 (1947) 120.—*Alsophila lepidoclada* CHRIST in K. SCH. & LAUT. Nachtr. (1905) 37; v. A. v. R. Handb. (1908) 37; Handb. Suppl. (1917) 62.

*Trunk* slender, to 2 m; fronds to 150 cm. *Stipe* 10–24 cm; scales to 20 by 4–5 mm, shining brown with dull thin edges; scales on upper part of stipe and on rachis paler. Lower *pinnae* gradually reduced, lowest 3–6 cm long, longest 16–22 cm. *Pinnules* to 20 by 8 mm, segments *c.* 6 pairs, distinctly oblique, entire or slightly crenate, lowest free or contracted on acroscopic base; costules little over 2 mm apart; veins 3–4 pairs, simple. *Sori* near costules, rather small, not indusiate, paraphyses not longer than sporangia. *Scales and hairs*: lower surface of main rachis densely covered with interlacing pale flexuous hairs which are branched at the base, with scattered flat elongate scales; pinna-rachis similarly clothed, the scales more abundant, to about 3 by  $\frac{2}{3}$  mm; pale hairs on costae more sparse, the scales bullate; hairs also scattered on lower surface of costules and veins.

Type specimen: SCHLECHTER 14417, Torricelli Mts, E. New Guinea (P; dupl. at K, BM, BO).

Distr. *Malaysia*: Central and E. New Guinea (3 collections).

Ecol. At 800–1000 m, 'frequent on slope in rain forest' (BRASS).

2. *Cyathea microphyloides* ROS. in Fedde, Rep. 12 (1913) 164; v. A. v. R. Handb. Suppl. (1917) 38.—*C. peranemiformis* C. CHR. Brittonia 2 (1937) 277.

*Trunk* slender, to 1 m; fronds less than 100 cm long. *Stipe* 3–10 cm; scales to 15 by 2 mm, median band shining, dark or sometimes partly or entirely pale, with broad dull fragile edges. Lower *pinnae* gradually reduced, lowest 3–5 cm long, longest to *c.* 20 cm. *Pinnules* to *c.* 30 by 10 mm, lobes almost all constricted at the base (connected by a very narrow wing along the costa) but only the lowest quite free, edges slightly crenate; costules to  $3\frac{1}{2}$  mm apart; veins 4–5 pairs, the lower ones forked. *Sori* to 3 or 4 pairs on each segment of a pinnule; indusium ultimately a shallow light brown cup round base of sorus; receptacle prominent, paraphyses slender, short. *Scales and hairs*: main rachis bearing many long narrow crisped spreading brown scales, and minute fringed scales, on lower surface; lower surface of pinna-rachis bearing many bullate-based acuminate brown scales, the smaller ones hair-pointed, and also crisped brown hairs; costae bearing similar small bullate scales.

Type specimen: KEYSER B71, Bolan Mts, E. New Guinea (S-PA; dupl. at B).

Distr. *Malaysia*: Eastern and Central New Guinea.

Ecol. At *c.* 1800–3000 m; BRASS notes of type of *C. peranemiformis* 'common in forests of slopes and valleys'.

3. *Cyathea perpelvigera* v. A. v. R. Nova Guinea 14 (1924) 11; COPEL. Philip. J. Sc. 77 (1947) 119, 120.

*Trunk* to  $2\frac{1}{2}$  m by 5 cm  $\phi$ ; leaf-bases persistent; fronds *c.* 10, spirally arranged. *Stipe* 15–20 cm, base bearing spines 2 mm long; scales shining brown with dull fragile edges, to 10 by almost 2 mm, narrower on distal part of stipe and on rachis; rachis bearing abundant crisped short brown hairs on lower surface and some residual very narrow long twisted scales. *Lamina* of frond 40–60 by 20–25 cm, lower *pinnae* gradually reduced. Largest *pinnae* 10–15 cm long, lowest *pinnae* 4 cm. *Pinnules* close together, more than 30 pairs on larger *pinnae*, to 15 by 5 mm, almost fully pinnate with *c.* 6 pairs of tertiary leaflets and a lobed apex; tertiary leaflets to 3 by almost 2 mm (fertile ones 1 mm wide), edges entire or crenate; veins 3–4 pairs, lowest forked. *Sori* 1–2 (rarely 3) to a leaflet; indusium forming a firm brown entire cup about half the height of the mature sorus. *Scales and hairs*: lower surface of pinna-rachis bearing copious crisped brown hairs, also brown bullate long-acuminate scales; similar scales on lower surface of costae, with a few hairs.

Type specimen: LAM 1441, ridge near Doorman summit, W. New Guinea (BO; dupl. at L, K, S, US, UC).

Distr. *Malaysia*: New Guinea, Moluccas (Ceram), N. Celebes (doubtful; plant young and sterile).

Ecol. At 1200–1800 m both in New Guinea and in Ceram; reported by BRASS as abundant in rain-forest in absence of woody undergrowth and by SCHODDE in mixed *Nothofagus* forest.

4. *Cyathea hunsteiniana* BRAUSE, Bot. Jahrb. 56 (1920) 58 (incl. *var. acuminata*); COPEL. Philip. J. Sc. 77 (1947) 119.

*Trunk* 2 cm  $\phi$ ; fronds to 100 cm long. *Stipe* 8–16 cm; scales to 13 by  $3\frac{1}{2}$  mm, dark with rather broad flabelloid edges. *Pinnae* 25–30 pairs, lower ones gradually reduced, lowest 3 cm long, longest 12 cm. *Pinnules* almost sessile, to 12 by 5 mm, segments to 7 pairs, lowest free and more or less lobed, middle ones constricted at base. *Sori* 1 or 2 to each lamina-segment; indusium a deep firm brown cup with even rim. *Scales and hairs*: lower surface of main rachis and pinna-rachis densely covered with appressed shining brown flexuous hairs; lower surface of costae with few such hairs; no scales seen.

Type specimen: LEDERMANN 11139, Hunstein-spitze, E. New Guinea.

Distr. *Malaysia*: Eastern New Guinea.

Ecol. At 1300–2000 m.

Notes. This is very near *C. perpelvigera*, but appears to lack scales on the frond. BRAUSE distinguished *var. acuminata* (at 2070 m), with fronds long-acuminate and sori always solitary; it looks like a less robust plant, possibly grown in a more shady place than usual.

5. *Cyathea arfakensis* GEPP in Gibbs, Arfak (1917) 69.—*Hemitelia arfakensis* v. A. v. R. Bull. Jard. Bot. Btzg II, n. 28 (1918) 26.

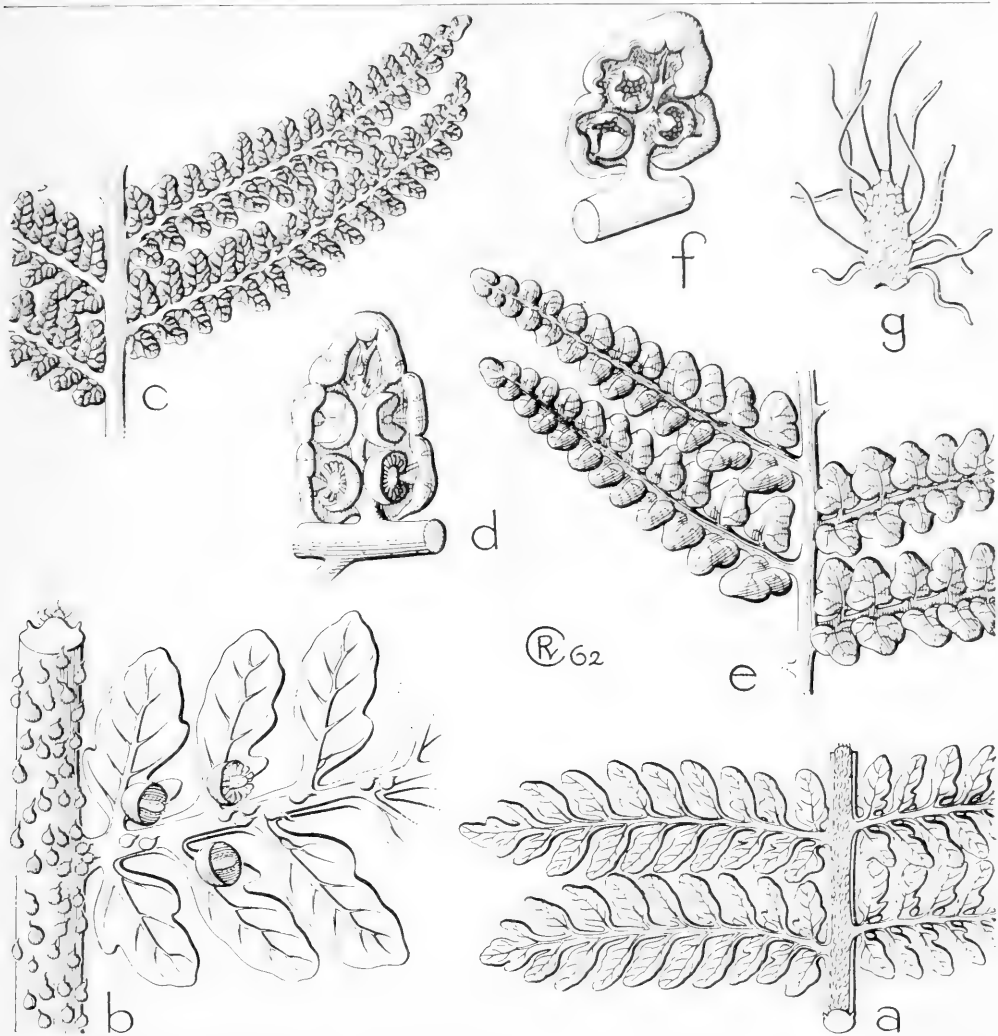


Fig. 10. *Cyathea hooglandii* HOLTUM. a. Part of pinna, upper surface,  $\times 2$ , b. same, lower surface, showing sori and bullate scales on pinna-rachis and costa,  $\times 6$ .—*C. dicksonioides* HOLTUM. c. Part of pinna, upper surface,  $\times 2$ , d. a single tertiary leaflet showing sori,  $\times 8$ .—*C. macgregorii* F. v. M. e. Part of pinna, upper surface,  $\times 2$ , f. one tertiary leaflet showing sori,  $\times 6$ , g. scale from costule,  $\times 40$  (a-b HOOGLAND 7203, c HOOGLAND & SCHODDE 7506, d ditto 7171, e-g HOOGLAND & PULLEN 5745).

Stipe 12 cm, dark, warty; scales 10 by 1 mm. Lamina c. 70 cm long, lowest pinnae 5 cm long, longest pinna  $8\frac{1}{2}$  cm. Pinnules to 11 mm by 4 mm, apex rounded, largest with 1 or 2 basal segments free as almost circular tertiary leaflets, rest of pinnule crenate; lowest pinnules of upper pinnae deflexed and overlapping main rachis. Sori in one row on each side of costa of pinnule and close to it; indusium a broad open dark brown cup with firm even edge. Scales and hairs: some small bullate scales on costae; no hairs seen on lower surface.

Type specimen: L. S. GIBBS 6008, Anggi Lakes, SW. Ridge, W. New Guinea (BM; dupl. at P, K).

Distr. Malaysia: W. New Guinea (2 collections).

Ecol. In undergrowth of mossy forest at 2500 m.

6. *Cyathea ledermannii* BRAUSE, Bot. Jahrb. 56 (1920) 56 (incl. var. *dilatata*, l.c. 58); COPEL. Philip. J. Sc. 77 (1947) 119.

Trunk slender, to  $2\frac{1}{2}$  m; fronds few, to 150 cm long. Stipe 30 cm, base bearing blunt spines to 1 mm high and dark shining scales 10–15 by  $1\frac{1}{2}$ –2 mm with pale edges. Largest pinnae 22 cm long. Pinnules to 23 by 8 mm, with c. 7 pairs of entire segments, lowest 2 segments free, next 2 pairs contracted at base, rest decurrent basiscopically to form a wing along the costa; costules  $2\frac{1}{2}$  mm apart; veins 5–6 pairs, mostly simple.

*Sori* 4–5 on each segment, near costules, usually not on basal veins; indusium a very firm deep cup. *Scales and hairs*: pinna-rachis glabrescent on lower surface or with a few narrow dark scales; costae and costules bearing a few rather large brown bullate scales (costae may have narrow flat scales also).

Type specimen: LEDERMANN 9651, Sepik region, E. New Guinea (B).

Distr. *Malaysia*: Central and Eastern New Guinea.

Ecol. At 200–1000 m, in rain-forest or mossy forest, locally abundant.

**7. *Cyathea hooglandii* HOLTUM**, Kew Bull. 16 (1962) 56.—Fig. 10a.

*Trunk* to 3 m by 10 cm  $\phi$ , bearing 10 fronds in two whorls of 5 (HOOGLAND); fronds to 140 cm long. *Stipe* 10 cm, densely covered with scales, dull and warty after fall of scales; scales to 20 by 1½ mm, lower ones very dark, shining, upper ones medium brown, all with rather broad paler fragile edges, not setiferous. Lower *pinnae* gradually reduced, lowest 2–3 cm long, longest 26 cm. Largest *pinnules* 20–30 by 7–8 mm, pinnate, with 7–11 pairs of tertiary leaflets, the distal ones joined by a narrow wing to costa; tertiary leaflets ovate to elliptic, to 4 by 1½ mm, edges of distal ones entire or sinuous, of basal ones more or less deeply lobed at the base, lobes 1–3, acute; veins 4 pairs, simple. A single *sorus* at base of each tertiary leaflet, apparently seated on its costule or at base of lowest acroscopic vein; indusium a firm saucer nearly 1 mm wide with the receptacle at its centre; receptacle elongate and slightly swollen; paraphyses slender, shorter than sporangia. *Scales and hairs*: lower surface of main rachis glabrescent, dull, minutely warty, with residual irregular small brown scales; lower surface of pinna-rachis rather closely covered with small brown, bullate scales, some hair-pointed but most not obviously so; similar smaller bullate scales on costae of pinnules, not on tertiary leaflets.

Type specimen: HOOGLAND & SCHODDE 7203, Western Highlands, NE. New Guinea (L).

Distr. *Malaysia*: NE. New Guinea (3 coll.).

Ecol. In *Nothofagus* forest at 3000 m (type); ‘in heavily mossed forest’, 3170 m (BRASS 30216).

Note. This species appears to be related to 3. *C. perpelvigera* and 2. *C. microphylloides*, but is quite peculiar in having the sori singly at the bases of the tertiary leaflets, apparently seated directly on the costule, not on one of the lateral veins as in all other species of *Cyathea* here reported. BRASS 30216 bears the note ‘leaves 7, pale, flat-spreading’; possibly the number of leaves in a whorl varies from 5 to 7.

**8. *Cyathea percrassa* C. CHR.** Brittonia 2 (1937) 279; COPEL. Philip. J. Sc. 77 (1947) 107.

*Trunk* 2–4 m by 8–12 cm  $\phi$ , bearing 6–12 fronds 125–200 cm long; lower *pinnae* gradually reduced, or one small pair near base and then a long gap to the next. *Stipe* not spiny, lower part covered with ascending rigid twisted scales 25–40 by 1–2 mm, with shining median band (pale, streaked, or

wholly brown) and a rather broad pale fragile edge; stipe and rachis also densely covered with small dull brown scales which have dark setiform apices; pneumathodes 4–6 mm long, well spaced, in a single row. Largest *pinnae* 30–40 cm long. Largest *pinnules* of type 80 by 22 mm, of another collection 55 by 13 mm, lowest segments free or nearly so, rest of pinnule lobed almost to the costa; costules 2½–3 mm apart; veins to 10 pairs, mostly forked; lamina-segments very firm, edges finely crenate and not reflexed, sinuses narrow. *Sori* near costules; indusium a firm light-brown cup, wider than deep, with even rim. *Scales and hairs*: lower surface of pinna-rachis densely covered with small scales which bear dark setae, also scattered narrow scales 3–5 mm long bearing a few dark setae on their fragile edges; costae copiously scaly, scales near base to 2 mm long, brown to pale with pale edges bearing dark setae, grading to small paler scales fringed with hairs; costular scales as those of costae but not over 1 mm long; lower surface of veins densely covered with very small scales, some setiferous.

Type specimen: BRASS 4375, Mt Albert Edward, E. New Guinea (A; dupl. at BM, MICH, BRI).

Distr. *Malaysia*: Eastern New Guinea.

Ecol. At 3000–3500 m, fairly common in valley forest (BRASS); fairly common in mossy forest (BRASS, HOOGLAND & PULLEN) or on edge of mossy forest.

**9. *Cyathea vandeusenii* HOLTUM**, Blumea 11 (1962) 529.

*Trunk* stout, to 2 m; fronds c. 10, spreading, 80–100 cm long. *Stipe* 12–18 cm, completely covered, as lower part of main rachis, with scales; scales pale, to 40 by 1–1½ mm, firm and shining with narrow dull fragile edges, thick and dark at base only, with an under-coat of small thin brown scales bearing long flexuous setae. Lowest *pinnae* 12–15 cm long, longest 23 cm. *Pinnules* to 50 mm long, 15 mm wide at base, tapering evenly from base to apex, 2–3 pairs of basal segments separately adnate to costa; costules 3½ mm apart; veins to 7 pairs; lamina-segments very rigid, with edges reflexed when dry, edges rather deeply crenate where fertile. *Sori* almost completely embedded in scales; indusium a complete light-brown cup with smooth edge, as wide as deep. *Scales and hairs*: lower surface of all rachises, costae and costules covered with a close felt of thin flat brown scales bearing many slender crisped marginal hairs and scattered flexuous brown setae; lower surface of veins bearing crisped pale hairs.

Type specimen: BRASS 29989, Eastern Highlands Distr., NE. New Guinea (L; dupl. at K, US).

Distr. *Malaysia*: NE. New Guinea (one collection).

Ecol. At 3700 m, ‘frequent in edges of patches of subalpine forest’.

**10. *Cyathea pruinosa* ROSENST.** in Fedde, Rep. 12 (1913) 163; V. A. v. R. Handb. Suppl. (1917) 29; COPEL. Philip. J. Sc. 77 (1947) 101.

*Trunk* 5 m; fronds 10–14. *Stipe* 15 cm or more, purplish with a fine glaucous covering, warty after fall of scales; scales near base of stipe to 30 by 1½ mm, stiff and twisted, dark brown, shining, with paler fragile edges. Lowest *pinnae* 15 cm long; largest *pinnae* 30–50 cm. Largest *pinnules* 50–75 by 15–17 mm, sessile, lobed nearly to costa throughout, lowest segment almost free, lower surface distinctly glaucous; costules 3–3½ mm apart; veins 9–10 pairs; lamina-segments rather rigid, segments crenate, most deeply so when fertile. *Sori* near costules; indusium at maturity a rather thin brown cup with entire rim, about as wide as deep. *Scales and hairs*: pinna-rachis rather pale, minutely warty on lower surface; scales on costae flat, broad, brown, bearing a few long dark setae; on costules imbricating flat broad scales as on costae, with ovate convex or almost bullate scales distally; a few similar smaller scales on lower surface of veins.

Type specimen: KEYSSER B44, Bolan Mts, E. New Guinea (S-PA; dupl. at B, UC).

Distr. *Malaysia*: Eastern New Guinea.

Ecol. At 2400–3000 m, on edge of forest and tree-fern grasslands; also (sterile) in undergrowth of forest.

Note. The type material did not include the stipe, description of which is taken from HOOG-  
LAND & SCHODDE 7633, which also bears the information that there were 14 fronds in two whorls.

**11. *Cyathea pycnoneura* HOLTUM, Blumea 11 (1962) 533.**

*Fronds* to 230 cm long. *Stipe* more than 30 cm, dark, spiny throughout, spines to nearly 3 mm long; scales many, dark, to 35 by 2 mm wide near base which is thick and hairy, flabelloid edges narrow and mostly abraded with scattered long dark setae; very small dull scales, some with dark setae, also present. Lowest *pinnae* not seen, longest 65 cm long. Largest *pinnules* 75–105 by 15–17 mm, sessile, lowest segment not free; costules 3–3½ mm apart; veins to 13 pairs; lamina-segments firm, falcate, crenate-serrate. *Sori* near costules; indusium a rather pale thin cup about as wide as deep; paraphyses shorter than sporangia. *Scales and hairs*: pinna-rachis pale beneath and covered sparsely with very small pale ± bullate scales which end in dark setae, scattered narrow dark scales with long marginal setae also present; scales on lower surface of costae rather broad, more or less bullate-based, acuminate, with scattered long marginal setae, also pale small bullate scales mostly lacking setae; costular scales pale, bullate, larger ones acuminate and sometimes with setae; all scales on costae and costules leaving very short hair-like bases when they fall; veins bearing scattered small pale scales on lower surface and many very short hairs.

Type specimen: PULLEN 562, Upper Omahaiga valley Goroka District, Territory of New Guinea (CANB, type; BM, L).

Distr. *Malaysia*: N.E. New Guinea (two collections).

Ecol. At 2300–2500 m in *Podocarpus-Lauraceae* forest.

**12. *Cyathea rigens* ROSENST. in Fedde, Rep. 12 (1913) 163; v. A. v. R., Handb. Suppl. (1917) 33; COPEL. Philip. J. Sc. 77 (1947) 103, 104.**

*Trunk* 3–5 m tall; fronds numerous, spreading, 100–150(–200) cm long. *Stipe* 7–17 cm, near base bearing many spines to 2 or 3 mm long; scales pale or dark, shining, with dull edges which often have long dark setae near base, 20–50 by 3–4 mm. Lower *pinnae* gradually reduced, or a gap between the small basal ones and the next; lowest 5–8 cm long, largest *pinnae* c. 30 cm. Largest *pinnules* 40–60 by 12–14 mm, deeply lobed, lowest segment not free; costules 3–3½ mm apart; veins to 8 pairs, mostly forked; lamina-segments crenate. *Sori* near costules; indusium a firm light brown shallow cup with even rim. *Scales and hairs*: pinna-rachis very scaly when young, larger scales narrow, flat, acuminate with a few dark marginal setae, these scales mostly caducous; towards apex of pinna-rachis some more persistent bullate-based scales; also on lower surface of pinna-rachis small scales bearing very fine crisped hairs; scales on costae near base narrow, flat, pale, acuminate with a few dark setae, distally bullate with long hair-point; on costules bullate hair-pointed scales grading to very fine pale hairs.

Type specimen: KEYSSER B79, Bolan Mts, E. New Guinea (S-PA; dupl. at B, UC).

Distr. *Malaysia*: Central and Eastern New Guinea, Goodenough Island.

Ecol. At 2000–2800 m on the mainland of New Guinea; on Goodenough Island at 1570–1600 m; in oak forest and mossy forest, locally abundant; also reported in undergrowth on edge of *Nothofagus* forest, and on edge of grassland.

**13. *Cyathea everta* COPEL. Un. Cal. Publ. Bot. 18 (1942) 218; Philip. J. Sc. 77 (1947) 103, pl. 2.—*C. globosora* COPEL. Un. Cal. Publ. Bot. 18 (1942) 218; Philip. J. Sc. 77 (1947) 106, pl. 4.**

*Trunk* up to 8 mm, 5–6 cm ø, bearing fronds 120–150 cm long. *Stipe* 20–30 cm, spiny throughout, spines 1–2 mm long; scales near base as in *C. rigens*; upper part of stipe bearing a thin felt of irregular small pale fringed scales; sometimes a single isolated small pinna near base of stipe. Lowest *pinnae* 12–15 cm long, longest 30 cm. *Pinnules* 35–50(–75?) by 11–15 mm, lobed almost to costa, lower segments of larger *pinnae* separated by a narrow wing along costa, not truly free; costules 3½ mm apart; veins to 8 pairs, mostly forked; lamina-segments crenate. *Sori* near costules; indusium a firm brown cup when mature, about as wide as deep. *Scales and hairs*: pinna-rachis bearing more or less abundant crisped hairs, also bullate-based hair-pointed scales, the scales often deciduous; lower surface of costae bearing pale acuminate bullate scales and sometimes crisped hairs.

Type specimen: BRASS 10712, near Lake Habema, W. New Guinea (A; dupl. at BO, UC).

Distr. *Malaysia*: Western New Guinea.

Ecol. At 1400–2800 m, in oak forest and mossy forest.

Note. Possibly this species should be united with *C. rigens*. It is sometimes difficult to distinguish minute fringed scales from separate hairs, and perhaps there are transitions between the two.

**14. *Cyathea cincinnata*** BRAUSE, Bot. Jahrb. 56 (1920) 52; COPEL. Philip. J. Sc. 77 (1947) 104.

*Stipe* 30 cm, scaly throughout; scales to 20 by 2 mm, shining brown, sometimes with a black median band, the dull flabelloid edges bearing many long setae. Lowest *pinnae* 15 cm long, longest *pinnae* 52 cm. *Pinnules* to 80 by 18 mm, sessile, lobed almost to the costa; costules 3½ mm apart; veins to 9 pairs; lamina-segments slightly toothed. *Sori* near the costules; indusium a firm brown cup with even edge, somewhat wider than deep; paraphyses short and slender. *Scales and hairs*: lower surface of pinna-rachis covered evenly with short crisped hairs, with scattered very narrow flexuous dark scales which bear a few dark flexuous marginal setae; lower surface of costae of lower *pinnules* bearing some crisped hairs near base; no scales seen on costae and costules.

Type specimen: LEDERMANN 11279, Sepik region, E. New Guinea (B).

Distr. *Malaysia*: E. New Guinea (one collection).

Ecol. At 1300 m.

**15. *Cyathea subtripinnata*** HOLTUM, Blumea 11 (1962) 534.

*Trunk* 2½ m, bearing 18 fronds which are not whorled. *Stipe* 12 cm, densely covered with scales throughout, warty after fall of scales; scales to 40 by 1½ mm wide at base, dark brown, shining, twisted, fragile edges narrow except near base, also under-coat of irregular small brown scales which are mostly not setiferous. *Rachis* dull, brown, glabrescent, minutely warty. Lowest *pinnae* 17 cm long, longest 40 cm. *Pinnules* to 65 by 17 mm, almost sessile, the larger ones with c. 6 pairs of quite free tertiary leaflets, remaining lamina-segments more or less broadly adnate to costa, distal ones connected by a narrow wing; costules (bases of tertiary leaflets) 4 mm apart; veins 7–8 pairs, mostly forked, middle ones sometimes twice forked, hardly raised on upper surface, impressed on lower surface; lamina-segments or tertiary leaflets rigid when dry, fertile ones lobed about half way to costule. *Sori* near costules; indusium a firm brown cup wider than deep; sporangia very numerous; paraphyses not seen. *Scales and hairs*: pinna-rachis dull, brown, glabrescent except for scattered small flat roundish entire pale or brown scales and a few very narrow dark brown scales, all lacking setae; costal scales like those of pinna-rachis but smaller ones sometimes convex; costules usually glabrous beneath.

Type specimen: SCHODDE 1763, Mt Giluwe, Southern Highlands Distr., Papua (CANB).

Distr. *Malaysia*: East New Guinea.

Ecol. Margin of alpine grassland and alpine shrubbery at 3120 m.

**16. *Cyathea orientalis*** (KUNZE) MOORE, Ind. Fil. (1861) 272; METT. Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 58; HOOK. & BAK. Syn. Fil. (1865) 24; RACIB. Fl. Btzig 1 (1898) 37; v. A. v. R. Handb. (1908) 21; Suppl. (1917) 29; BACKER & POSTH. Varenfl. Java (1939) 24.—*Disphenia orientalis* KUNZE, Bot. Zeit. 6 (1848) 283 (excl. syn.).—*C. arborea* [non (L.) SM.] var. *pallida* HASSK. Obs. Bot. Fil. 1 (1856) 15.—Fig. 7, 9c.

*Stipe* dark, to at least 50 cm, bearing copious spines 1½ mm long when old; scales abundant, dark, to 35 by 3 mm, pale edges narrow, bearing dark setae; basal part of scale bearing superficial outgrowths; pneumathodes 4–7 mm long, in a single row. Lower *pinnae* somewhat reduced, largest 65 cm long. *Pinnules* almost sessile, commonly 100 by 18 mm, lobed almost to the costa, lowest 1–2 segments almost free, apex rather abruptly acuminate; costules 3–3½ mm apart; veins 9–10 pairs; lamina-segments falcate, apex blunt, edges crenate towards apex. *Sori* near costules; indusium a rather thin brown cup about 1 mm ø, slightly constricted at mouth, about as wide as deep; apex of receptacle level with mouth of indusium; paraphyses slender, short. *Scales and hairs*: lower surface of main rachis shortly spiny in basal part to minutely warty distally, with residual very small scales some of which bear short dark setae; similar scales on lower surface of pinna-rachis; costae bearing very small brown short-fringed scales and flat ovate to elongate entire scales (mostly caducous); costules of sterile *pinnules* bearing flat to convex ovate almost entire uniformly brown scales.

Type specimen: ZOLLINGER 2538, Tengger Mts, E. Java (holotype not seen; dupl. at L, P, BM, BO).

Distr. *Malaysia*: W.—E. Java, Lesser Sunda Is (Bali, Lombok, Flores).

Ecol. In mountain forest, 1000–1800 m.

**17. *Cyathea apoensis*** COPEL. in Elmer, Leaf. Philip. Bot. 3 (1910) 802; v. A. v. R. Handb. Suppl. (1917) 26; COPEL. Fern Fl. Philip. 2 (1960) 213.—*C. lobata* COPEL. Philip. J. Sc. 81 (1952) 15, pl. 13; Fern Fl. Philip. 2 (1960) 214.

*Stipe* unknown. *Pinnae* to 40 cm long. *Pinnules* commonly to 65(–85) by 14–18 mm, lowest 1–2 segments quite free, rest of *pinnule* lobed almost to costa; costules 3–3½ mm apart; veins 7–9 pairs, mostly forked; lamina-segments rather deeply crenate-serrate or basal ones lobed up to ½ way to costule, each lobe bidentate. *Sori* near costules; indusium a rather thin cup with even rim (often broken when old), about as wide as deep; paraphyses slender, short. *Scales and hairs*: main rachis dark, minutely warty on lower surface, bearing residual very small irregular dull brown scales which sometimes bear a dark seta, also a few elongate dark flat scales with pale edges; pinna-rachis similarly scaly, often with very narrow brown scales 3–5 mm long; costae near base rather copiously scaly, scales to 3 mm long and ¾ mm wide, shining brown, flat, tapering evenly from base, edges with a few dark setae, distal scales similar but shorter, more ovate; no scales seen on costu-



les, but may be present on costules of sterile pinnales (none such seen).

Type specimen: ELMER 11482, Mt Apo, Mindanao (MICH; dupl. at US, FI, K, BO, P, A, SYD, L, BM).

Distr. *Malaysia*: Philippines (Mindanao, Negros, southern Luzon).

Ecol. 'In dense woods along Seriban creek, Mt Apo, alt. 1800 m' (ELMER).

**18. *Cyathea costalisora* COPEL.** Un. Cal. Publ. Bot. 18 (1942) 218; Philip. J. Sc. 77 (1947) 101, pl. 1.

*Trunk* to 4 m, branching near base. *Stipe* warty after fall of scales, c. 20 cm; scales to 25 by 1 mm, central band dark shining brown, pale dull edges bearing a few long dark setae; upper part of stipe and rachis bearing very narrow flexuous spreading scales to 10 mm long. Lowest *pinnae* c. 12 cm long, longest 20–30 cm. Largest *pinnules* 35–45 by 8–10 mm, lobed nearly to costa, lowest 1–2 segments sometimes a little constricted at base, not free, apex abruptly pointed; costules 2–2½ mm apart; veins 7–8 pairs, mostly forked; lamina-segments firm, crenate. *Sori* near costules (on type only on basal veins and so only near costa); indusium at maturity a firm dark cup with slightly contracted mouth, wider than deep, facing obliquely away from costule. *Scales and hairs*: pinna-rachis densely scaly on lower surface, scales 4–5 mm long with dark median band and broad pale edges bearing a few long setae, also smaller pale scales with some setae; costae and costules of type almost glabrous on lower surface.

Type specimen: BRASS 9488, Lake Habbema, W. New Guinea (A; dupl. at BO, BM).

Distr. *Malaysia*: Western New Guinea (2 collections).

Ecol. In forest: near Lake Habbema (3225 m) in moist hollows; in Arfak Mts (1900 m) near Lake Giji.

Note. The specimen from Arfak Mts differs from the type as follows: stipe-scales 2½ mm wide, pale or dark near apex; on lower surface of costae and costules are narrow pale scales bearing a few dark marginal setae; lamina-segments deeply serrate.

**19. *Cyathea pallidipaleata* HOLTUM,** Kew Bull. 16 (1962) 60.

*Stipe* 10 cm, medium brown, densely covered with shining pale brown scales to 32 by 1 mm, their dull edges narrow; similar smaller scales at first all along rachis but caducous. Lowest *pinna* 13 cm long, longest *pinna* 25 cm; *pinnules* at 60° to pinna-rachis. *Pinnules* to 45 by 11 mm, abruptly acuminate, lobed nearly to costa, lowest segment nearly free; costules 2½ mm apart; lamina-segments thick and rigid, edges not reflexed, deeply crenate, the larger crenations notched; veins 7–8 pairs. *Sori* near costules; indusium a complete firm dark open cup. *Scales and hairs*: on pinna-rachis many very small dark short-setiferous scales and some residual long dark scales; on costae shining dark brown flat ovate scales bearing a few setae; on costules many very small dark setiferous scales, these mostly caducous.

Type specimen: EYMA 776, Tinabang, W. side of Mt Rante Mario, Subdistr. Enrekang, SW. Celebes (BO).

Distr. *Malaysia*: SW. Celebes: Latimodjong Mts.

Ecol. Mountain forest, 3000 m.

**20. *Cyathea coactilis* HOLTUM,** Blumea 11 (1962) 533.

*Trunk* 2½ m, bearing 10 fronds in 2 whorls; fronds c. 170 cm long. *Stipe* c. 10 cm, not spiny, densely covered with scales throughout; scales to 35 by less than 1 mm wide at base, pale with darker narrow fragile edges; under-coat of small dull appressed fringed scales, some with apical seta. *Rachis* persistently covered on lower surface with a thin felt of small scales as stipe with a few long narrow pale scales. Lowest *pinna* c. 6 cm long, longest 30 cm. Largest *pinnules* sessile, abruptly acuminate, 37 by 12 mm, lowest pair of segments almost or quite free, then a few pairs joined by narrow wing along costa; costules 3 mm apart; veins 6–7 pairs; lamina-segments firm, crenate. *Sori* near costules; indusium a thin cup, wider than deep; paraphyses slender, dark. *Scales and hairs*: pinna-rachis covered completely with a felt of scales which are small, light brown, thin, copiously short-fringed, not bullate nor acuminate but sometimes with dark setiform apex, also a few long narrow pale scales with fragile non-setiferous edges; costae bearing larger dark flat scales with irregular marginal setae; costular scales flat, brown, usually not setiferous, distal ones very small; on lower surface of veins very short hairs (bases of scales?).

Type specimen: SCHODDE 1887, Mt Giluwe, Southern Highlands Distr., Papua (CANB).

Distr. *Malaysia*: E. New Guinea (once collected).

Ecol. In alpine shrubbery at 3000 m.

**21. *Cyathea parva* COPEL.** Un. Cal. Publ. Bot. 18 (1942) 219; Philip. J. Sc. 77 (1947) 120, pl. 13.

*Trunk* 1½ m tall, 3½ cm ø, bearing 4 fronds 90 cm long. *Stipe* c. 10 cm, copiously warty; scales to 15 by 1½ mm, pale or sometimes dark near apex, the thin dull edges bearing a few long dark setae. Lower *pinnae* gradually reduced, lowest 5–6 cm long, longest 17 cm, *pinnules* well spaced. *Pinnules* to 30 by 6 mm, not acuminate, lobed almost to costa, lowest segment not free; costules 1½–2 mm apart; veins to 6 pairs, lower ones forked; lamina-segments firm, the fertile ones crenate, sterile almost entire. *Sori* near costules; indusium a very narrow dark red ring round base of receptacle. *Scales and hairs*: lower surface of main rachis almost completely covered with very small dull long-fringed scales, with scattered large pale scales; on lower surface of pinna-rachis many pale thin-edged scales 5 by 1 mm, long-acuminate, sometimes bearing long dark marginal setae, these scales bullate at base near apex of pinna, also many minute scales bearing long marginal hairs; costal scales pale, narrow,

with bullate bases, grading to rather large pale bullate scales.

Type specimen: BRASS 12197, 15 km SW of Bernhard Camp, Idenburg River, W. New Guinea (UC; dupl. at MICH, BO, A, L).

Distr. *Malaysia*: Western New Guinea (one collection).

Ecol. In undergrowth of rain forest in gully, 1700 m.

**22. *Cyathea wengiensis* (BRAUSE) DOMIN, Pterid.** (1929) 263; COPEL. Philip. J. Sc. 77 (1947) 113.—*Alsophila wengiensis* BRAUSE, Bot. Jahrb. 49 (1912) 13, fig. 1c; v. A. v. R. Handb. Suppl. (1917) 68.—*Alsophila hieronymi* BRAUSE, Bot. Jahrb. 49 (1912) 14; v. A. v. R. Handb. Suppl. (1917) 67.—*C. brauseana* DOMIN, Pterid. (1929) 262.

*Stipe* to 10 cm or more, bearing spines to 2 mm long; scales not seen. Lowest *pinna* 10 cm long, longest 48 cm. Largest *pinnules* 70 by 12–18 mm (sometimes larger; see note below); lobed to c. 1 mm from costa, lowest segment not quite free; costules 3½ mm apart; veins 9–11 pairs; lamina-segments firm, edges more or less crenate, sinuses narrow. *Sori* medial, or distal ones near costule; indusium a dark ring less than ½ mm ø round base of receptacle, sometimes not quite encircling receptacle; paraphyses longer than sporangia. *Scales and hairs*: on lower surface of pinna-rachis crisped light brown hairs, or small scales bearing such hairs, throughout but more abundant distally, also dark scales to 3 mm long with broad pale edges bearing long dark setae; on costae similar hairs or hair-bearing scales and scattered broad scales bearing few setae; on costules flat pale scales to bullate scales.

Type specimen: SCHLECHTER 16100, in forest near Wengi, NE. New Guinea (B; dupl. at P, UC).

Distr. *Malaysia*: Eastern New Guinea.

Ecol. In forest or secondary growth after cultivation, up to 600 m.

Notes. A specimen collected from 'tall garden re-growth' in Sepik District (DARBYSHIRE & HOOGLAND 8042) agrees with the type except in larger size of pinnules, largest being 120 by 23 mm with costules 5–5½ mm apart and sterile segments very deeply lobed. This large size may be due to conditions of habitat.

In position of *sori* *C. wengiensis* agrees with *C. macgillivrayi* (BAK.) DOMIN, but normally the latter has no indusium. Specimens with variable very small indusia which are mostly hemitelioid appear intermediate between the two species.

**23. *Cyathea batjanensis* (CHRIST) COPEL.** Philip. J. Sc. 4 (1909) Bot. 45.—*Alsophila batjanensis* CHRIST in Warb. Monunia (1900) 90; v. A. v. R. Handb. (1908) 38.—*Alsophila saparuensis* v. A. v. R. Bull. Dép. Agr. Ind. Néerl. n. 18 (1908) 2; Handb. (1908) 38.—*Alsophila straminea* GEPP in Gibbs, Arfak (1917) 192.—*C. saparuensis* v. A. v. R. Bull. Jard. Bot. Btgz II, n. 28 (1918) 13.—*C. straminea* v. A. v. R. l.c. 14 (non KARST.

1856).—*C. gepiana* DOMIN, Acta Bot. Bohem. 9 (1930) 118.—Fig. 9a.

*Trunk* slender. *Stipe* 15 cm or more long, bearing many warts or conical spines 1 mm high; scales dark brown with paler fragile edges. Lower *pinnae* often considerably reduced (to 10 cm long or less), longest to 45 cm. Largest *pinnules* 70–90 by 15–18 mm, lobed almost to the costa; costules 3½–5 mm apart; veins to 10 pairs; lamina-segments rather thin, edges rather strongly crenate towards apices. *Sori* medial; indusium a small ring round base of receptacle; paraphyses longer than sporangia, several cells wide at the base. *Scales and hairs*: lower surface of pinna-rachis and costae bearing flexuous pale hairs and scattered irregular small pale scales with long flexuous slender marginal hairs; no bullate scales on costae or costules.

Type specimen: WARBURG 17844, Mt Sibela, Batjan, Moluccas (B; not seen at Paris).

Distr. *Malaysia*: Moluccas (Batjan, Ceram, Tidore, Ternate, Buru, Saparua, Halmaheira); Western New Guinea.

Ecol. At about 600 m.

**24. *Cyathea ternatea* v. A. v. R.** Bull. Jard. Bot. Btgz III, 5 (1922) 191.

*Stipe* bearing many spines to 2½ mm long; scales to 25 by 3 mm, shining brown with narrow dull edges. *Pinnae* to 65 cm long. *Pinnules* to 150 by 22 mm, long-acuminate, lowest on stalks 2–3 mm long, lowest segment almost free; costules 4½ mm apart; veins to 11 pairs, mostly forked (some twice forked); lamina-segments firm, rather strongly crenate throughout. *Sori* medial; indusium a small disc round base of receptacle; paraphyses long. *Scales and hairs*: pinna-rachis and costae bearing many very small irregular shortfringed scales, also on pinna-rachis a few broad thin scales having odd marginal setae; on costules sometimes brown bullate scales which are ciliate towards acuminate apices.

Type specimen: BEGUIN 1126, Ternate (BO; dupl. at L, P).

Distr. *Malaysia*: Moluccas (Ternate, 2 collections).

Ecol. At 600–1300 m.

**25. *Cyathea albidosquamata* ROSENST.** in Fedde, Rep. 12 (1913) 525; v. A. v. R. Handb. Suppl. (1917) 31; COPEL. Philip. J. Sc. 77 (1947) 104, 121.—*C. pumilio* v. A. v. R. Bull. Jard. Bot. Btgz II, n. 28 (1918) 14.

*Stipe* to at least 20 cm, scaly throughout, scales firm, pale, shining, with dull fragile edges; on lower surface of rachis similar scales to 7 by 1 mm, bearing a few long dark setae, also a close cover of pale flexuous hairs. *Pinnae* to 35 cm long. Largest *pinnules* 32–40 by 12 mm, lobed almost to costa; costules 3–3½ mm apart; veins 4–6 pairs; lamina-segments firm, slightly crenate. *Sori* near costules; indusium an almost flat disc c. 1 mm wide, sometimes slightly asymmetric; paraphyses not longer than sporangia. *Scales and hairs*: on lower surface of pinna-rachis a close cover of pale hairs,

also narrow pale acuminate scales, all except the largest bullate at base; on costae similar hairs and scales, distal scales bullate; on costules small pale bullate scales and pale crisped hairs.

Type specimen: KEYSSER 177, Sattelberg, NE. New Guinea (S-PA; dupl. at B, UC).

Distr. *Malaysia*: Moluccas (Ceram), New Guinea.

Ecol. At 1200–1500 m.

Note. The type of *C. pumilio*, from Ceram (RUTTEN 373) differs from the type of *C. albidosquamata* chiefly in having more sparse and hardly bullate scales on the pinna-rachis.

**26. *Cyathea javanica* BL.** En. Pl. Jav. (1828) 245 (*incl. var. rigida*, p.p.); METT. Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 56; HOOK. Syn. Fil. (1865) 23; RACIB. Fl. Btzig I (1898) 35; v. A. v. R. Handb. (1908) 23; Suppl. (1917) 32; BACKER & POSTH. Varenfl. Java (1939) 24.—*Hemitelia caudipinnula* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 7 (1912) 16; Handb. Suppl. (1917) 48.—*Hemitelia barisanica* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 20 (1915) 17; Handb. Suppl. (1917) 49.—*Alsophila benculensis* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 23 (1916) 2; Handb. Suppl. (1917) 493.—*Alsophila palembanica* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 23 (1916) 4; Handb. Suppl. (1917) 493.—*C. benculensis* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 28 (1918) 14.—*C. palembanica* v. A. v. R. l.c. 13.—*C. caudipinnula* DOMIN, Pterid. (1929) 263.—*C. barisanica* DOMIN, l.c.—Fig. 9b.

Trunk to 10 m. Stipe 10–30 cm, bearing many spines to 1 mm long, and dark fragile-edged scales to 15 by 1 mm. Lower *pinnae* gradually reduced, lowest 5–10 cm long where stipe is 10 cm, longer where stipe is longer; longest *pinnae* to 70 cm. Largest *pinnules* sessile, caudate-acuminate, 80–100 by 15–23 mm, lobed almost to costa, lowest segments not free; costules 4–5 mm apart; veins to 10 pairs; lamina-segments firm, slightly crenate or the largest fertile ones sometimes deeply so, sinuses narrow except near base of largest fertile *pinnules*. *Sori* near costules except the basal ones; indusium a rather firm disc about as wide as base of mature sorus, sometimes excentric or almost entirely on costular side of receptacle; paraphyses slender, short. *Scales and hairs*: lower surface of rachis and pinna-rachis closely hairy throughout, hairs short, crisped, with some residual narrow dark scales; on lower surface of costae similar hairs, also narrow scales near base grading to bullate-acuminate scales distally; on costules small brown bullate scales; upper surface of pinna-rachis and costae usually glabrous, sometimes slightly hairy.

Type specimen: BLUME, West Java (L; dupl. K).

Distr. *Malaysia*: Sumatra, Java.

Ecol. In forest, 250–1500 m.

Note. The type specimen of *Hemitelia barisanica*, from Sumatra, is unusually large, with *pinnules* to 120 by 28 mm, costules to 6 mm apart; the indusia are usually excentric and sometimes only on the costular side of the receptacle; hairs and scales agree with type.

Some specimens at Kew of *C. javanica* var. *rigida* so named by BLUME are *C. crenulata* BL.

**27. *Cyathea hymenodes* METT.** Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 57; HOOK. Syn. Fil. (1865) 24; v. A. v. R. Handb. (1908) 24.—*C. korthalsii* METT. Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 57; HOOK. Syn. Fil. (1865) 25; v. A. v. R. Handb. (1908) 21; Suppl. (1917) 27, p.p.—*C. amphicosmioides* v. A. v. R. Bull. Jard. Bot. Btzig III, 2 (1920) 138.—*C. arthropterygia* v. A. v. R. *ibid.* III, 5 (1922) 188.—*C. latebrosa* var. *indusiata* HOLTUM, Gard. Bull. S.S. 8 (1935) 305; Rev. Fl. Mal. 1 (1954) 121.

Stipe not spiny, sometimes with a pair of short *pinnae* near base; scales 20–35 by 1½–4 mm, dark, fragile edges soon disappearing. Lower *pinnae* more or less reduced; longest 50 cm long. Largest *pinnules* sessile, 70–100 by 15–20 mm, lowest segment (rarely several pairs of segments) almost free and often separated from next by a narrow wing along costa, rest of *pinnule* lobed almost to costa; costules 3–4 mm apart; veins 8–10 pairs; lamina-segments rather thin, more or less deeply crenate (lowest sometimes deeply lobed). *Sori* near costules; indusium an almost circular brown disc about as wide as base of sorus, its edge entire, often somewhat asymmetric about the receptacle, sometimes only on the costular side; receptacle swollen, paraphyses short, apical ones sometimes flat at the base. *Scales and hairs*: short crisped hairs more or less abundant on distal part of lower surface of pinna-rachis; scales near bases of costae elongate, usually entire but sometimes with a marginal seta, grading to bullate scales distally; bullate scales on costules, often deciduous from fertile *pinnules*; upper surface of costae always hairy.

Type specimen: KORTHALS, Sumatra (L).

Distr. *Malaysia*: Sumatra, Malay Peninsula.

Ecol. In mountain forest at 900–2000 m.

Note. METTENIUS described the indusia of both *C. hymenodes* and *C. korthalsii* as breaking (*fatiscens*) but they are in almost all cases flat discs with an entire margin which gives no sign of having been formed by the breakdown of a complete indusium. In both types some of the indusia are hemitelioid, some are symmetrical about the receptacle as centre. Probably the hemitelioid indusia are more abundant in the type of *C. korthalsii*.

**28. *Cyathea patellifera* v. A. v. R.** Bull. Jard. Bot. Btzig II, n. 16 (1914) 4; Handb. Suppl. (1917) 31.

Stipe to 50 cm, dark at base, red-brown upwards, spiny throughout, spines near base 2 mm long, distally less than 1 mm, scaly near base; scales to 20 by 2 mm, firm, medium brown, fragile edges early caducous. Middle *pinnae* 35–40 cm long. Largest *pinnules* 50–70 by 15 mm, abruptly pointed or short-acuminate, almost sessile, lowest pair of segments quite free, then 1 to several pairs constricted on acroscopic side at base, connected to rest by a narrow wing on costa; costules 3 mm apart; veins 6–8 pairs; lamina-segments firm, more

or less deeply crenate, free ones sometimes lobed half-way to costule. *Sori* near costules; indusium a firm brown disc hardly as wide as base of ripe sorus, its edges rather irregularly lobed; paraphyses as long as sporangia, abundant, some of them 2 cells wide at base. *Scales and hairs*: lower surface of pinna-rachis covered throughout with short crisped hairs, more copiously towards apex; scales near base of costa elongate, brown, entire, some with bullate base, grading to brown bullate scales; scattered short crisped hairs also on lower surface of costae; small entire brown bullate scales on costules.

Type specimen: MATTHEW 667, Mt Singgalang, Sumatra (BO; dupl. at K).

Distr. *Malaysia*: Central Sumatra (2 collections).

Ecol. In forest, 2200–2400 m.

Notes. The second collection (SCHIFFNER P223), from same locality, has longer pinnules than the type, with fewer free or sub-free basal segments, segments less deeply lobed, and scales paler and less rigid than those of the type. Though the indusium has in all cases an irregular margin, there is no indication that it represents the remains of a larger indusium that previously covered the sorus.

**29. *Cyathea negrosiana*** CHRIST, Philip. J. Sc. 2 (1907) Bot. 181; v. A. v. R. Handb. (1908) 786; COPEL. Fern Fl. Philip. 2 (1960) 214.

*Stipe* c. 15 cm long, warty; scales to 20 by 1½ mm, dark brown, shining, with narrow dull concolorous edges. Lowest *pinna* 5–6 cm long, longest *pinna* 35 cm. Largest *pinnules* 70 by 14 mm, sessile, acuminate, lowest 1–2 segments free or nearly so, rest of pinnule lobed nearly to costa; costules 3 mm apart; veins 8–10 pairs; lamina-segments rather thin, slightly crenate, sinuses narrow. *Sori* near costules; indusium ultimately a rather thin brown disc usually widest on the costular side, where it is conspicuous, sometimes with uneven edge and possibly the remains of a former complete indusium; receptacle very prominent; paraphyses shorter than sporangia. *Scales and hairs*: lower surface of pinna-rachis covered with very numerous small pale bullate scales, hairs lacking; lower surface of costae and costules bearing similar but smaller scales, some elongate almost flat entire scales also near base of costae.

Type specimen: WHITFORD, F. B. 1536, Mt Silay, Negros (P; dupl. at MICH).

Distr. *Malaysia*: Philippines (Negros, Leyte, Biliran).

Ecol. At 1000 m.

**30. *Cyathea catillifera*** HOLTUM, Kew Bull. 16 (1962) 53.

*Trunk* branching at base, 1 m by 10 cm  $\sigma$ , bearing about 6 fronds, stipe-bases persistent. *Stipe* 50 cm, base dark brown, paler upwards, closely spiny near base, minutely warty between spines, the latter rather slender, to 3 mm long; scales near base of stipe to 20 by 2–2½ mm,

shining dark brown with concolorous thinner edges; very small irregular brown scales on surface between thorns. Lowest *pinna* 23 cm long, longest *pinna* 29 cm. Largest *pinnules* 55 by 15 mm, lowest segment not free, apex acuminate; costules 3–3½ mm apart; veins to 8 pairs; lamina-segments rather rigid, edges deeply crenate when fertile. *Sori* near costules; indusium a dark brown disc c. 1 mm wide, symmetric about the receptacle or slightly wider on costular side, with thin paler edges; paraphyses slender, as long as sporangia. *Scales and hairs*: lower surface of main rachis light brown, dull, minutely warty, glabrescent; lower surface of pinna-rachis similar near base but bearing scattered very narrow long entire brown scales, distal half more or less covered with small light brown entire more or less bullate scales; costae rather densely scaly throughout lower surface, scales mostly ovate in outline, larger ones bullate, shining light brown, smaller ones of all sizes; costules bearing similar bullate scales and sometimes very narrow entire scales; veins bearing neither scales nor hairs.

Type specimen: BRASS 4549, Murray Pass, Wharton Range, Central Division, Papua (BRI; dupl. at NY).

Distr. *Malaysia*: Eastern New Guinea (one collection).

Ecol. At 2840 m.

**31. *Cyathea horridula*** COPEL. Un. Cal. Publ. Bot. 18 (1942) 219; Philip. J. Sc. 77 (1947) 111, pl. 8.

*Trunk* 3 m, slender. *Stipe* 40 cm, bearing many short spines (to 1 mm long), scaly near base; scales to 15 by 1½ mm, pale, with distinct fragile edges bearing occasional long dark setae. Lowest *pinna* 25 cm long, longest 45 cm. *Pinnules* to 55 by 13 mm, lowest 1–2 pairs of segments separately adnate to costa, rest of pinnule lobed nearly to costa; costules 3 mm apart; veins to 9 pairs; lamina-segments rather thin. *Sori* near costules; indusium a very small dark brown disc, somewhat irregular in shape, receptacle usually excentric. *Scales and hairs*: lower surface of pinna-rachis bearing elongate pale scales having long dark setae, also many very small pale fringed scales; scales on costae elongate, pale, with some long setae, grading to pale bullate scales lacking setae distally and on costules, very small scales bearing long slender hairs also present.

Type specimen: BRASS 12043, near Idenburg River, W. New Guinea (UC; dupl. at MICH, A).

Distr. *Malaysia*: Western New Guinea (one collection).

Ecol. At 1700 m.

**32. *Cyathea tenuicaulis*** DOMIN, Acta Bot. Bohem. 9 (1930) 165; COPEL. Philip. J. Sc. 77 (1947) 113. —*Alsophila tenuis* BRAUSE, Bot. Jahrb. 56 (1920) 71, non *C. tenuis* BRAUSE, 1911.

*Trunk* 1–2 m, 2 cm  $\sigma$ , bearing fronds 75 cm long. *Stipe* 18–40 cm, dull purplish, warty; scales to 8 by 1 mm, rigid, medium brown, fragile edges soon abraded. Lowest *pinna* 7–11 cm long, longest 21 cm. Largest *pinnules* 40–50 by 13–15 mm, lobed

to 1–2 mm from costa, no free basal segments; costules 3 mm apart (fully fertile pinnules) to 4 mm (sterile); veins 7–9 pairs; lamina-segments entire or slightly crenate. *Sori* near costules; indusium very thin and fragile, appearing as an irregular fragment on old sori; receptacle swollen, paraphyses thin and short. *Scales and hairs*: lower surface of pinna-rachis bearing rather sparse short crisped hairs, also scattered elongate dark scales bearing marginal setae, and distally pale bullate scales; lower surface of costae bearing crisped hairs and sometimes long setiferous scales near base, also small pale bullate scales throughout; bullate scales also on costules.

Type specimen: LEDERMANN 7498, Sepik region, NE. New Guinea (B).

Distr. *Malaysia*: Eastern New Guinea.

Ecol. In forest 300–1500 m.

Notes. The type specimen is from an old frond; no remnants of indusia have been seen on it. Specimens collected by CARR (13363, 14542), which agree in scaliness and form of pinnules with the type, show fragments of indusia on most sori. If the type is truly lacking in indusia, CARR's specimens should probably be regarded as representing a distinct species.

33. *Cyathea sumatrana* BAK. J. Bot. 18 (1880) 209; v. A. v. R. Handb. (1908) 23; Suppl. (1917) 32.—*C. schizochlamys* BAK. J. Bot. 18 (1880) 209; v. A. v. R. Handb. (1908) 25.—*C. subuliformis* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 11 (1913) 6; Handb. Suppl. (1917) 32.—*C. tuberculata* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 28 (1918) 11.

*Stipe* to 60 cm or more, warty, copiously scaly throughout; scales to 25 by 1–3 mm, dark to medium brown, shining, with paler fragile edges. Longest *pinnae* 50 cm long. *Pinnules* to 85 by 18 mm, lowest 1–2 segments of larger pinnules free and sometimes deeply lobed, rest of pinnule lobed almost to costa; costules 3–4 mm apart; veins 9–12 pairs, those in lobes of free segments forked twice or more; lamina-segments firm, crenate. *Sori* near costules; indusium at first completely covering sorus, thin and fragile, breaking and partly caducous at maturity; receptacle swollen; paraphyses slender, shorter than sporangia. *Scales and hairs*: lower surface of pinna-rachis covered throughout with short flexuous brown hairs, also when young with narrow flexuous brown scales 5–10 mm long often bearing long dark setae on their paler edges, those near apex of pinna with bullate base; lower surface of costae bearing bullate scales throughout, those near base of costae having long acuminate apices, some crisped hairs also present; bullate scales present on costules; upper surface of costae bearing dark antrorse hairs throughout (difference from *C. javanica*).

Type specimen: BECCARI 438, Mt Singgalang, Sumatra (K; dupl. at FI).

Distr. *Malaysia*: Sumatra, Malay Peninsula.

Ecol. In forest, 500–1500 m.

34. *Cyathea klossii* RIDL. Trans. Linn. Soc. II, Bot. 9 (1916) 251; v. A. v. R. Handb. Suppl. (1917) 489.

*Trunk* 1½ cm ø. *Stipe* 10 cm; scales dark, dull, thick, to 8 by hardly 1 mm, with a few long marginal setae towards apex. *Frond* c. 60 cm long, simply pinnate; *pinnae* close and spreading throughout, several lower pairs gradually reduced, lowest 3 cm long, longest 70 by 18 mm, lobed to c. 1½ mm from costa; costules of pinna-lobes to 3½ mm apart; veins to 6 pairs, usually simple; lamina-segments entire or slightly crenate, firm. *Sori* near costules; indusium at first completely covering sorus, rather thin and pale but not translucent, breaking irregularly and in part caducous; receptacle somewhat swollen; paraphyses short, slender. *Scales and hairs*: on lower surface of main rachis throughout rather copious small pale bullate scales, with residual very narrow dark scales 3–4 mm long; costae of *pinnae* bearing scattered small pale bullate scales on lower surface, hairy on upper surface near base only; no scales seen on costules.

Type specimen: KLOSS, Camp III, Dec. 1912, Mt Carstensz, W. New Guinea (BM; dupl. at K).

Distr. *Malaysia*: W. New Guinea.

Ecol. At 750 m and lower.

Note. KLOSS made two collections, one labelled Camp III, one Camp III–IV; the former includes the trunk. As the trunk is well developed, this appears to be a species which always has simply pinnate fronds. It has no obvious near relatives among species with bipinnate fronds in New Guinea.

35. *Cyathea trachypoda* v. A. v. R. Bull. Jard. Bot. Btzig III, 5 (1922) 191.—*Alsophila alpina* v. A. v. R. *ibid.* II, n. 20 (1915) 4; Handb. Suppl. (1917) 62.—*C. alpina* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 28 (1918) 13 (not *C. alpina* ROTH, 1800).—*C. alpicola* DOMIN, Acta Bot. Bohem. 9 (1930) 89.

*Stipe* at least 50 cm, bearing scattered spines to 3 mm long, more or less completely covered throughout (as also lower surface of rachis) with a thin pale woolly layer of small finely-fringed scales; larger scales scattered throughout, and also present on rachis, to 30 by 4 mm, dark, shining brown with rather broad paler fragile edges, those on main rachis commonly 10 by 1 mm. *Pinnae* to 40 cm long. Largest *pinnules* 100 by 18–20 mm, sessile, lowest segment free, then 1–2 pairs adnate and joined by a wing along costa; costules 3½ mm apart; veins 10–11 pairs; lamina-segments thin, entire or slightly crenate. *Sori* near costules; indusium at first complete, the top web-like, breaking and mostly falling away, leaving an irregular disc with lacerate edges; receptacle elongate and somewhat swollen; paraphyses short. *Scales and hairs*: lower surface of pinna-rachis at first covered with fine woolly scales as main rachis, these more or less caducous, with scattered narrow entire pale to light brown scales; lower surface of costae bearing small fringed scales and a few longer narrow ones; costules bearing ovate to elongate flat or convex pale scales, their edges fragile and lacerate, grading to very small scales.

Type specimen: BÜNNEMEIJER 10205, Mt Kerintji, Sumatra (BO; dupl. at K).

Distr. *Malaysia*: Central Sumatra.

Ecol. In forest, 2000–2750 m.

Notes. The type of *Alsophila alpina* has rachises almost completely covered on lower surface with woolly scales, but others from type locality have only remnants of such a covering. This species is very near *C. crenulata*, but differs in its spiny stipe.

A specimen from Harau-Canyon, near Pakjumbuh, at 800 m (MEIJER 5282) has a spiny stipe with fine woolly covering, but costae and costules almost glabrous apart from minute long-fringed scales on costae, like those forming the woolly covering on the stipe but smaller.

36. *Cyathea crenulata* BL. En. Pl. Jav. (1828) 244; HOOK. Sp. Fil. 1 (1844) 25; Syn. Fil. (1863) 23; METT. Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 57; RACIB. Fl. Btzig 1 (1898) 36; v. A. v. R. Handb. (1908) 21; Bull. Jard. Bot. Btzig II, n. 20 (1915) 9, 10; Handb. Suppl. (1917) 27, 488, Corr. 63, 64 (excl. f. *latissima*, f. *squamulosa*, f. *subspinulosa*); BACKER & POSTH. Varenfl. Java (1939) 26.—*C. javanica* var. *rigida* BL. En. Pl. Jav. (1828) 245, p.p.—(?) *C. polycarpa* JUNGH. Nat. Geneesk. Arch. N.I. 2 (1845) 40; Flora 30 (1847) 522.—*C. excelsa* [non SW.] KUNZE, Bot. Zeit. 6 (1848) 284.—*C. spinulosa* var. *muriculata* HASSK. in Hook. J. Bot. Kew Misc. 7 (1855) 322; v. A. v. R.

Handb. (1908) 25; Suppl. (1917) 36.—*C. leucophaea* HASSK. in Hook. J. Bot. Kew Misc. 7 (1855) 323; Obs. Fil. Jav. 1 (1856) 26; v. A. v. R. Handb. (1908) 24.—*C. zollingeriana* METT. Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 57 (not of v. A. v. R. Handb. (1908) 20, 785; Suppl. (1917) 26, Corr. 42, which is *C. oinops* HASSK.).—*C. oinops* (non HASSK.) RAC. Fl. Btzig 1 (1898) 63 ('*sinops*'); v. A. v. R. Handb. Suppl. (1917) Corr. 44.—*C. distans* ROSENST. Med. Rijksherb. 31 (1917) 2.—Fig. 9f, 11.

Stipe warty, not spiny; scales to 25 by 3 mm, dark with paler fragile edges; pneumathodes in double row; main rachis rather pale when dry, finely warty, glabrescent. Lower pinnae not greatly reduced, longest 60 cm long. Largest pinnules commonly 70–100 by 17–20 mm, in some cases 25–30 mm wide (*C. sinops*, *C. distans*), lobed almost to the costa, the wider ones with a few pairs of basal segments separately adnate to costa and joined by a narrow wing; costules  $3\frac{1}{2}$ –5 mm apart; veins to 12 pairs, mostly forked, middle ones often 2-forked; lamina-segments firm, crenate, the basal ones where fertile often deeply lobed. Sori near costules; indusium at first complete, thin, translucent, mostly caducous after breaking, leaving an irregular disc with pale thin edges; receptacle swollen, paraphyses short. Scales and hairs: pinna-rachis rather pale (green when living), finely warty on lower surface, residual scales small, pale, with short fringe of hairs; similar scales abundant on costae, especially near base, sometimes with flat elongate brown scales with pale edges which may bear dark setae; on costules of sterile pinnules pale brown convex to bullate scales.

Type specimen: BLUME, Java (L; dupl. at K).

Distr. *Malaysia*: Java, Lesser Sunda Is (Flores).

Ecol. In forest, 1700–2700 m.

Notes. *C. trachypoda*, *C. macropoda* and *C. magnifolia* of Sumatra are closely allied, and clear distinctions need to be established; the warty, not spiny, stipe of *C. crenulata* seems to be distinctive. *C. sinops* and *C. distans* were described from specimens with unusually wide pinnules having several basal segments separately adnate to the costa. It may be that these should rank as a distinct species, as *C. incisoserrata* COPEL. is here ranked as distinct from *C. latebrosa*.

37. *Cyathea macropoda* DOMIN, Acta Bot. Bohem. 9 (1930) 133.—*C. longipes* v. A. v. R. Bull. Jard. Bot. Btzig III, 5 (1922) 189 (non COPEL. 1917).

Stipe nearly 100 cm, dark at base and armed with spines to 5 mm long, paler distally with very short spines, pneumathodes in a single row, well spaced; scales not seen; rachis pale, lower surface glabrescent and somewhat warty. Lower pinnae slightly reduced, longest 50 cm long. Pinnules to 70 by 17 mm, abruptly short-acuminate to caudate, 1–2 basal segments free, rest of pinnule lobed almost to costa; costules  $3\frac{1}{2}$ –4 mm apart; veins 10 pairs; lamina-segments firm, very slightly crenate. Sori near costules; indusium at first complete, very thin over apex of sorus, breaking and falling, leaving an irregular disc. Scales and hairs: pinna-rachis beneath smooth, pale, gla-



Fig. 11. *Cyathea crenulata* BL., showing how old fronds persist and cover upper part of trunk. Kawah Baru, Papandajan, Java (VAN STEENIS).

brescent; scales on costae few, those near base narrow, dark with pale edges bearing long dark setae, grading to ovate flat pale scales bearing a few short marginal hairs distally and on costules; no bullate scales seen.

Type specimen: BÜNNEMEIJER 9642, Mt Kerintji, Sumatra (BO; dupl. at L, U, US, A).

Distr. *Malaysia*: Central Sumatra (3 collections).

Ecol. At 2000–2400 m.

**38. *Cyathea saccata*** CHRIST, Ann. Jard. Bot. Btzg 19 (1904) 42; v. A. v. R. Handb. (1908) 19.

*Stipe* 25 cm long, medium brown, bearing slender spines 3 mm long; scales not seen. *Pinnae* to at least 43 cm long. *Pinnules* to 80 by 17 mm, lowest on stalks 2½ mm long, basal segments not free, apex caudate-acuminate; costules 4–4½ mm apart; veins 8–9 pairs; lamina-segments rather thin, light green, conspicuously crenate. *Sori* near costules; indusium complete, thin, translucent, breaking and caducous except for a brown disc at the base. *Scales and hairs*: pinna-rachis light brown, shortly spiny near base, glabrescent; on lower surface of costae some very small pale scales with long crisped pale fringing hairs, also elongate flat pale scales grading to rather sparse pale bullate scales on distal part of costae and on costules.

Type specimen: P. & F. SARASIN 2045, Mt Topapu, Central Celebes (P; dupl. at BAS).

Distr. *Malaysia*: Celebes.

Ecol. At 1300–1700 m.

**39. *Cyathea magnifolia*** v. A. v. R. Bull. Jard. Bot. Btzg III, 2 (1920) 135.—*C. acanthopoda* v. A. v. R. *ibid.* III, 5 (1922) 190.

*Stipe* dark with spines to 5 mm long; scales not seen. Largest *pinnae* c. 100 cm long. Largest *pinnules* 150–175 by 30–40 mm, lobed almost to costa; costules 4–5½ mm apart; veins c. 12–(14) pairs; lamina-segments firm, crenate. *Sori* near costules, at first covered with a thin complete indusium which breaks at maturity and is in part caducous, leaving an irregular disc with pale thin edges. *Scales and hairs*: pinna-rachis smooth and glabrous beneath; costae bearing a few small pale fringed scales; on costules a few entire bullate or strongly convex scales.

Type specimen: BÜNNEMEIJER 4175, Mt Malintang, Sumatra (BO; dupl. at L).

Distr. *Malaysia*: Sumatra.

Ecol. At 1100–2000 m.

Note. This species is near *C. crenulata* BL., differing in large size, long spines on stipe and very slight scaliness.

**40. *Cyathea acanthophora*** HOLTUM, Kew Bull. 16 (1962) 51.

*Stipe* to 80 cm; base dark with rather slender spines 4–7 mm long; scales early caducous, those on a young frond to 20 by 1 mm, medium shining brown with narrow dull concolorous edges lacking setae; pneumathodes 14–17 mm long, in a single row, rather widely spaced. *Pinnae* to 65 cm long.

*Pinnules* more or less articulate to rachis, largest 85–100 by 15–18 mm, lowest segment contracted at base but not free, rest of pinnule lobed almost to the costa; costules 4–4½ mm apart; veins 9–10 pairs; lamina-segments rather thin, more or less crenate, separated by sinuses ½ width of segments. *Sori* near costules; indusium at first covering sorus, very thin and mostly caducous, leaving a thin basal disc which either has the receptacle at its centre or may be only on costular side of receptacle; paraphyses short. *Scales and hairs*: pinna-rachis smooth and glabrous, pale; lower surface of costae bearing some residual flat elongate entire brown scales, grading to small flat scales; pale bullate scales on costules.

Type specimen: CLEMENS 34012, Mt Kinabalu, N. Borneo (BO; dupl. at US).

Distr. *Malaysia*: N. Borneo.

Ecol. In forest, at 1250–2000 m.

**41. *Cyathea rubiginosa*** (BRAUSE) DOMIN, Acta Bot. Bohem. 9 (1930) 154; COPEL. Philip. J. Sc. 77 (1947) 109.—*Alsophila rubiginosa* BRAUSE, Bot. Jahrb. 56 (1920) 66.—*Alsophila hunsteiniana* BRAUSE, *ibid.* 65.—*C. albidula* DOMIN, Acta Bot. Bohem. 9 (1930) 88.

*Stipe* 60 cm, dark purplish with many small conical spines to 1 mm high; scales to 15 mm (5 cm?) by hardly 1 mm wide above the base, thick at the base, edges pale and thin, bearing many long flexuous setae, also apparently superficial setae, near base of scale; very small dull brown scales bearing short dark setae also present. Lowest *pinna* 25 cm long, longest 42 cm. *Pinnules* well-spaced, to 67 by 17 mm, lobed to c. 1 mm from costa, subsessile, acuminate; costules 4–4½ mm apart; veins to 8 pairs; lamina-segments rigid, edges crenate. *Sori* on distal veins near costule, on basal veins further from it; indusium very thin, at first covering sorus, breaking and mostly caducous, leaving an irregular disc round base of sorus. *Scales and hairs*: pinna-rachis smooth and more or less glabrescent, usually with scattered narrow dull copiously setiferous scales 3–6 mm long and very small irregular non-setiferous dull brown scales; basal scales on costae elongate, dull, with irregular long setae, grading to pale bullate scales distally and on costules, some bullate scales bearing setae.

Type specimen: LEDERMANN 12539, Sepik Region, NE. New Guinea (B).

Distr. *Malaysia*: New Guinea.

Ecol. In rocky open forest or mossy forest, at 1100–2840 m.

**42. *Cyathea apiculata*** (ROSENST.) DOMIN, Pterid. (1929) 262.—*Alsophila apiculata* ROSENST. in Fedde, Rep. 13 (1914) 213; v. A. v. R. Handb. Suppl. (1917) 73.—*Alsophila indrapurae* v. A. v. R. Bull. Jard. Bot. Btzg II, n. 20 (1915) 2; Handb. Suppl. (1917) 63.—*C. crenulata* f. *subspinulosa* v. A. v. R. Handb. Suppl. (1917) 28.—*C. indrapurae* v. A. v. R. Bull. Jard. Bot. Btzg II, n. 28 (1918) 13.—*C. paleata* COPEL. Un. Cal. Publ. Bot. 14 (1929) 372, t. 56.



*Stipe* more than 30 cm, dark at base, paler upwards, not spiny, scaly almost throughout; scales to 15 by 3 mm, dark with paler fragile edges. *Pinnæ* to at least 40 cm long. *Pinnules* to 75 by 20 mm, almost sessile, caudate-acuminate, lobed almost to costa; costules 4-4½ mm apart; veins 10 pairs; lamina-segments slightly crenate, sinuses narrow. *Sori* near costules; indusium very thin and fragile, breaking and mostly caducous; receptacle globular; paraphyses short, slender. *Scales and hairs*: pinna-rachis smooth and glabrescent beneath, not hairy; costal scales few, those near base flat, ovate, bearing a few setae on pale edges; costular scales broad, thin, pale, not bullate.

Type specimen: J. WINKLER, Pea Radja, Batakerland, Sumatra (ROSENST., Fil. Sumatr. Exsic. 197, S-PA; dupl. at BM, L, P, UC).

Distr. *Malaysia*: Sumatra.

Ecol. In forest, at 1800 m.

Note. Under the original description of *C. indrapuræ*, three separate collections, made by C. G. MATTHEW in different localities, were cited. In view of the name *indrapuræ*, the specimen *n.* 374, from Indrapoera (= Mt Kerintji) is selected as type, and appears to me to be not different from *C. apiculata*; *n.* 696, from Mt Merapi, is *C. hymenodes* METT.

43. *Cyathea bunnemeijerii* v. A. v. R. Bull. Jard. Bot. Btzig III, 5 (1922) 187.

*Stipe* dark, at least 30 cm, near base bearing many conical spines hardly 1 mm long; scales dark with paler fragile edges, mostly caducous. *Pinnæ* to 40 cm or more long. *Pinnules* to 70 by 16 mm, lobed almost to costa, lowest segment almost free; costules 3½-4 mm apart; veins to 10 pairs; lamina-segments rather thin, drying very dark, edges crenate. *Sori* near costules; indusium thin, at first completely covering sorus, breaking and in part falling, the persistent part sometimes cup-shaped; paraphyses longer than sporangia, in some cases 2 cells wide at base. *Scales and hairs*: pinna-rachis purplish beneath, slightly warty, glabrescent; scales at base of costa brown, flat, elongate, entire, grading to paler ovate or bullate scales distally and on costules.

Type specimen: BÜNNEMEIJER 5839, Mt Ranai Bunguran, Natuna Is (BO; dupl. at L).

Distr. *Malaysia*: Natuna Islands (NW. of Sarawak).

Ecol. In open scrub on summits of two hills, at 600 m.

44. *Cyathea excavata* HOLTUM, Gard. Bull. S. S. 8 (1935) 306; Rev. Fl. Malaya 2 (1954) 121; MOLESWORTH ALLEN, Gard. Bull. Sing. 17 (1959) 255, photogr. facing p. 266.—Fig. 12.

*Trunk* to 2 m, sometimes with lateral buds forming small crowns of fronds; fronds to 2 m long. *Stipe* at least 40 cm, smooth and green (pale when dry); basal scales few, dull, thin, soon disappearing; pneumathodes 15-20 mm long, in a single almost continuous row, at base of stipe shorter and deeply excavated. *Pinnæ* to 60 cm long, lowest somewhat reduced. Largest *pinnules* commonly 80-100 by



Fig. 12. *Cyathea excavata* HOLTUM. Trunk-apex, showing deeply excavated pneumathodes arranged as V below base of a stipe. Cameron Highlands, Malaya (R. E. HOLTUM).

18-22 mm, sometimes to 130 by 27 mm, sessile, rather shortly acuminate, lobed almost to costa, lowest segment not free; costules 4-5 mm apart; veins 10-12(-14) pairs, often twice forked, pinnately branched where segments are deeply lobed; lamina-segments thin, the larger ones usually lobed ⅓-½ towards costule. *Sori* near costules, usually only on 1-3 basal pairs of veins; indusium pale, thin, covering young sorus completely but soon breaking, leaving an irregular persistent disc as large as base of sorus; receptacle swollen, often split when dry; paraphyses short. *Hairs and*



scales: pinna-rachis smooth and glabrous; costal scales sparse, brown, thin, entire, broadly and irregularly ovate, sometimes with a few dark setae; thinner similar scales on costules, distal ones pale, entire, flat; on veins many conspicuous very small hairs (bases of former scales).

Type specimen: HOLTUM 23538, Cameron Highlands, Malaya (S; dupl. at BO, K).

Distr. *Malaysia*: Malay Peninsula.

Ecol. Only known on Main Range in Cameron Highlands district at c. 1500 m; originally found in primary forest, in recent years on stream-sides in clearings and on forest edges, also in open grassy places (MOLESWORTH ALLEN, *l.c.*). Old fronds persist, hanging down and covering the trunk, as in *C. orientalis* (also in *C. crenulata*).

**45. *Cyathea christii* COPEL.** Philip. J. Sc. 1, Suppl. II (1906) 144; *ibid.* 4 (1909) Bot. 49; v. A. v. R. Handb. (1908) 785; Suppl. (1917) 29; COPEL. Fern Fl. Philip. 2 (1960) 217.

*Stipe* to 15 cm. Lower *pinnae* gradually reduced (sometimes a gap between lowest and next ?), lowest 5 cm or more long, longest 50 cm. *Pinnules* to 70 by 15 mm, lobed nearly to costa; costules 3–3½ mm apart; veins to 8 pairs; lamina-segments rather thin, more or less crenate. *Sori* near costules; indusium at first completely covering sorus, rather thin, breaking irregularly and sometimes in part caducous. *Scales and hairs*: pinna-rachis pale and glabrescent on lower surface, warty towards base, sometimes with residual narrow scales bearing a few setae; bullate scales present throughout lower surface of costae and on costules; sometimes narrow setiferous scales present also near base of costae.

Type specimen: COPELAND 1141, Mt Apo, Mindanao (MICH; dupl. at US).

Distr. *Malaysia*: Philippines (Mindanao).

Ecol. At 900–1800 m.

**46. *Cyathea geluensis* ROSENST.** in Fedde, Rep. 5 (1908) 371; *ibid.* 12 (1913) 525, *incl. var. tomentosa* ROSENST.; v. A. v. R. Handb. Suppl. (1917) 30; COPEL. Philip. J. Sc. 77 (1947) 102.—*C. novoguineensis* BRAUSE, Bot. Jahrb. 49 (1912) 12, fig. 1B; v. A. v. R. Handb. Suppl. (1917) 35.—*C. sepikensis* BRAUSE, Bot. Jahrb. 56 (1920) 54; COPEL. Philip. J. Sc. 77 (1947) 103.—*C. subspatulata* BRAUSE, Bot. Jahrb. 56 (1920) 53.

*Trunk* slender; fronds to c. 10, 100–230 cm long. *Stipe* variable in length, warty or shortly spiny, scaly near base; scales pale, or partly or wholly dark, with dull fragile edges, commonly to 15 by 2 mm, in some specimens to 20 by 5 mm; stipe also covered with a more or less continuous layer of pale flexuous hairs or very small scales bearing such hairs. Lower *pinnae* reduced, sometimes continuously to a small size (5–8 cm long), sometimes a single small pair near base and then a gap; longest *pinnae* 25–45 cm long. Largest *pinnules* commonly 40–60 by 12–15 mm, on some plants to 80 by 20 mm, almost sessile, acuminate, lobed almost to costa, lowest segment sometimes almost free; costules 3½–4 mm apart; veins 7–9 pairs;

lamina-segments rather thin, crenate to subentire. *Sori* near costules; indusium pale and thin but firm, at first covering sorus, breaking irregularly and persistent; paraphyses slender, as long as sporangia. *Scales and hairs*: lower surface of main rachis and pinna-rachis closely covered with entangled flexuous pale hairs, with more or less abundant pale scales mostly bullate at base; costae rather closely covered with pale bullate scales, sometimes near base also flexuous hairs and elongate pale flat scales; pale bullate scales on costules.

Type specimen: WERNER 80, Mt Gelu, NE. New Guinea (S-PA; dupl. at B).

Distr. *Malaysia*: Central and Eastern New Guinea, Louisiade Archipelago.

Ecol. In forest at 1000–2000 m on mainland; at 700–900 m on the islands, mostly in mossy forest.

Note. Possibly more than one species should be recognized; specimens examined seem to show various combinations of characters, especially as regards length of stipe and degree of reduction of lower *pinnae*.

**47. *Cyathea macgregorii* F. v. M.** Trans. R. Soc. Victoria 1 (1889) 40; BAK. J. Bot. 28 (1890) 104; v. A. v. R. Handb. (1908) 17; RIDL. Trans. Linn. Soc. II, Bot. 9 (1916) 251; C. CHR. Brittonia 2 (1937) 280.—*C. keysseri* ROSENST. in Fedde, Rep. 12 (1913) 164; v. A. v. R. Handb. Suppl. (1917) 23.—*C. cheilanthisoides* COPEL. Un. Cal. Publ. Bot. 18 (1942) 219; Philip. J. Sc. 77 (1947) 121, pl. 14.—Fig. 10e, f, g, 13.

*Trunk* to 3 m, to 24 cm ø, bearing up to 60 fronds 70–100 cm long. *Stipe* 5–15 cm, its base covered with shining brown dull-edged scales to 50 by 2–3 mm, warty and glaucous beneath after fall of scales; main *rachis* more or less persistently covered with small pale long-fringed scales, also narrow elongate thin pale scales, sometimes quite glabrescent. Lower *pinnae* gradually reduced, sometimes irregularly spaced, with a rather long gap between lowest *pinnae* (sometimes hidden by basal scales) and the next; lowest *pinna* 5–7 cm long; longest *pinna* 11–18 cm long. Largest *pinnules* 20–35 by 7–8 mm, bearing free but almost sessile very rigid tertiary leaflets, their bases 2–2½ mm apart. Largest *tertiary leaflets* commonly 3 by 2½ mm, ovate to deltoid, edges strongly reflexed and inrolled, more or less lobed near base; veins to 4 pairs, basal ones forked, strongly raised on lower surface but not on upper. *Sori* 4–6 on largest tertiary leaflets, fewer on smaller ones; indusium firm, brown, at first covering sorus, breaking irregularly and persistent; receptacle swollen, no persistent paraphyses. *Scales and hairs*: pinna-rachis and costae more or less persistently scaly on lower surface as main rachis, at length glabrescent and finely warty; costules bearing small long-fringed pale or brown scales between the sori.

Type specimen: W. MCGREGOR 63, Mt Knutsford, E. New Guinea (MEL; dupl. at K, P).

Distr. *Malaysia*: New Guinea.

Ecol. In open peaty grassland or on edge of forest, sometimes gregarious, 3000–3700 m.



Fig. 13. *Cyathea macgregorii* F. v. M., Mt Wilhelm, Eastern Highlands, Territory of New Guinea, 3450 m (R. D. HOOGLAND).

48. *Cyathea gleichenioides* C. CHR. Brittonia 2 (1937) 281; COPEL. Philip. J. Sc. 77 (1947) 123.—Fig. 1-2, 14.

Differs from *C. macgregorii* as follows: pinnae to 10½ cm long; pinnules mostly 13-15 mm long, basal acroscopic pinnule to 17 mm; tertiary leaflets almost circular, c. 1 mm long and wide, bearing 1 or 2 sori.

Type specimen: BRASS 4595, Murray Pass, Wharton Range (BM; dupl. at A, BO, BRI).

Distr. Malaysia: Eastern New Guinea.

Ecol. 'A conspicuous feature of the open grasslands' at 2840-3680 m (BRASS).

Note. CHRISTENSEN stated that another distinctive character of this species in the occurrence of short pinnae close to the base of the stipe, with

a gap of 15 cm to the next pair; but such a condition has also been seen in fronds which have leaflets like typical *C. macgregorii*. It seems that there is a good deal of variation in the disposition of the lower pinnae in the latter species. It seems to me also possible that the distinction of size of tertiary leaflets is not a constant one, in which case *C. gleichenioides* should be united with *C. macgregorii*.

49. *Cyathea havilandii* BAK. Trans. Linn. Soc. II, Bot. 4 (1894) 249; v. A. v. R. Handb. (1908) 22; C. CHR. Gard. Bull. S. S. 7 (1934) 221.—*C. paleacea* COPEL. Philip. J. Sc. 12 (1917) Bot. 53.—*C. rigida* COPEL. l.c.

Trunk very short; fronds almost erect, to c. 100



Fig. 14. *Cyathea gleichenioides* C. CHR. (BRASS 4265), top of trunk and bases of fronds, showing lowest pinnae partly covered by mass of scales. Mt Albert Edward, Papua, 3680 m (L. J. BRASS).

cm long. *Stipe* 30–40 cm, dark and warty where scales are removed, densely scaly throughout; scales near base to 15 by 1–2 mm, shining medium brown with very narrow concolorous fragile edges, size decreasing gradually upwards; upper part of stipe on abaxial surface densely covered also with much smaller scales of same colour, each ending in a long flexuous brown seta. Lower *pinnae* not much reduced; longest pinna 10–16 cm long. *Pinnules* to 25 by 7 mm, only a few near the base of larger *pinnae* free, rest separately adnate to pinna-rachis or connected by a narrow wing; largest pinnules, where fertile, lobed about halfway to costa, smaller and sterile ones slightly lobed; costules 2 mm apart; veins 2–3 pairs, strongly raised on lower surface; lamina very rigid, drying dark. *Sori* in a single row on each side of costa of pinnule, 1 or 2 to each vein-group; indusium very firm and dark, covering sorus to maturity, then gaping a little at the apex and breaking irregularly; paraphyses slender, short. *Scales and hairs*: main rachis densely and persistently scaly beneath throughout as upper part of stipe, some scales on distal part having bullate bases; pinna-rachis and costae of pinnules similarly scaly, scales smaller, costal ones mostly quite bullate, all ending in a long flexuous shining brown hair (hair-tip of costal scales often more than 1 mm long); upper surface of main rachis and pinna-rachis densely hairy, hairs long, darker than scales, antrorse; upper surface of costae glabrescent.

Type specimen: HAVILAND 1485, Mt Kinabalu, N. Borneo (K).

Distr. *Malaysia*: North Borneo.

Ecol. Abundant in the low open *Leptospermum-Dacrydium* forest of the ridges on Mt Kinabalu, 2400–3000 m.

50. *Cyathea imbricata* v. A. v. R. Nova Guinea 14 (1924) 11; C. CHR. *Brittonia* 2 (1937) 282; COPEL. *Philip. J. Sc.* 77 (1947) 123.

*Trunk* to 2 m; fronds 60–70 cm long. *Stipe* 7½–10 cm, dark, bearing spines 1 mm long, scaly when young; largest scales 12–15 by 2–4 mm, castaneous with paler fragile edges; small scales forming a woolly covering also present. Lower *pinnae* gradually reduced, lowest less than 5 cm long; middle *pinnae* close and imbricate, to 8½ cm. *Pinnules* to 18 by 8 mm, deeply lobed except towards apex, lobes close, 2–3 by 2 mm, thick and rigid but edges not reflexed; veins 4–5 pairs, simple or forked. *Sori* 1–4 to each lobe of lamina; indusium firm, at first quite covering sorus, breaking irregularly and persistent. *Scales and hairs*: pinna-rachis glabrescent beneath, residual scales firm, brown, with thin paler edges bearing a few short hairs and a hair-point; scales on costae similar but smaller, with long caudate tips, mostly caducous.

Type specimen: LAM 1625, foot of Doorman summit, W. New Guinea (BO; dupl. at S, US, L, U, UC).

Distr. *Malaysia*: Western New Guinea.  
Ecol. In open forest at 3240 m.

**51. *Cyathea longipes* COPEL.** Philip. J. Sc. 12 (1917) Bot. 54; C. CHR. Gard. Bull. S. S. 7 (1934) 222.

*Stipe* slender, to 200 cm, dark and copiously spiny near base; spines to 5 mm long; basal scales mostly caducous, rather broad; no persistent small scales. *Pinnae* to at least 70 cm long. *Pinnules* all stalked except distal ones, stalks of lowest on lower *pinnae* to 10 mm, on smaller *pinnae* 3–6 mm; largest *pinnules* 100–130 by 20–32 mm, acuminate, 1–3 pairs of basal segments free or separately adnate and connected by a costal wing, rest of *pinnule* lobed almost to costa; costules  $4\frac{1}{2}$ –6 mm apart; veins 10 pairs; lamina-segments crenate or the lowest ones more deeply lobed. *Sori* near costules; indusium rather thin, at first completely covering sorus, breaking irregularly and mostly persistent; receptacle swollen; paraphyses slender, about as long as sporangia. *Scales and hairs*: main rachis and pinna-rachis quite glabrescent, rather pale, sparsely short-spiny; scales on lower surface of costae ovate-acuminate, thin, entire, brown, shorter and more or less bullate distally; bullate-acuminate scales on costules.

Type specimen: CLEMENS 10915, Mt Kinabalu, North Borneo (MICH; dupl. at K, BO, UC, A).  
Distr. *Malaysia*: North Borneo.

Ecol. In ridge forest at 1250–1500 m, only on Marai-Parai spur of Mt Kinabalu, locally abundant.

**52. *Cyathea acuminata* COPEL.** Philip. J. Sc. 81 (1952) 15; Fern Fl. Philip. 2 (1960) 213.

*Stipe* not known. *Pinnae* to 70 cm long. Largest *pinnules* 100–120 by 22 mm, long-acuminate, lower ones on stalks to 4 mm long; all segments separated by rather wide sinuses, several lower pairs separately adnate to costa; costules  $4\frac{1}{2}$ –6 mm apart; veins to 12 pairs; lamina-segments rather thin, strongly crenate-serrate. *Sori* near costules; indusium at first quite covering sorus, rather firm, breaking irregularly and persisting; receptacle much swollen, bearing some small scales at its apex; paraphyses slender. *Scales and hairs*: pinna-rachis glabrescent beneath, bearing scattered small spines near base; scales near base of costae elongate, flat, dull brown, entire, grading to bullate ones distally and on costules.

Type specimen: RAMOS & EDANO, BS 30900, Jamindan, Capiz Prov., Panay (UC; dupl. at S, US, K, P, BM).

Distr. *Malaysia*: Philippines (Panay, Samar).

Note. The type of this species and other specimens were distributed from Manila as *C. spinulosa*.

**53. *Cyathea insulana* HOLTUM,** Kew Bull. 16 (1962) 56.

*Trunk* 8–10 m, 14 cm  $\sigma$ ; fronds spreading, 3 m long including stipe. *Stipe* 100 cm, covered with many thick conical spines 2 mm long and throughout with a thin felt of very small pale-brown short-fringed or setiferous scales; large scales abundant along edges of grooves of adaxial surface of basal

25 cm of stipe, these scales 35–45 mm long, shining castaneous, rigid, much twisted, with pale fragile edges, largest scales  $1\frac{1}{2}$ –3 mm wide at base; pneumathodes in a single row on each side of stipe, 7–11 mm long, those near base deeply excavated. *Pinnae* to at least 50 cm long. Largest *pinnules* 120–130 mm long, caudate-acuminate, lobed nearly to costa with basal 1–2 segments separately adnate; sterile *pinnules* 30 mm wide, fertile 20 mm, lowest ones with stalks 2 mm long; costules to 5 mm apart; veins 12–14 pairs; lamina-segments strongly crenate or lowest ones more deeply lobed. *Sori* near costules; indusium at first completely covering sorus, thin and pale, breaking irregularly. *Scales and hairs*: scales on pinna-rachis abundant, very small, light brown, mostly setiferous; on costae similar scales and sometimes also narrow setiferous ones; on costules similar very small setiferous scales, also a few larger thin ovate flat or convex scales bearing a few slender setae; on veins many very small light brown almost circular somewhat bullate scales, not setiferous.

Type specimen: BRASS 24725, Goodenough I., Milne Bay District, Papua (A; dupl. at L).

Distr. *Malaysia*: d'Entrecasteaux Is. (Goodenough I., Normanby I., Fergusson I.).

Ecol. In mossy forest or in ravines near rain-forest-mossy forest transition, 750–1600 m.

Note. The specimens here included from Normanby and Fergusson Is are smaller than the type and from lower elevations; they have stipes less spiny, *pinnules* to 82 by 20 mm. They also show elongate narrow setiferous scales on costae; possibly these were caducous on the type specimen.

**54. *Cyathea pseudomuelleri* HOLTUM,** Kew Bull. 16 (1962) 61.—Fig. 15.

*Trunk* 4 m, bearing many fronds; stipe-bases persistent. *Stipe* 10 cm, above base dull, rather pale, finely warty; scales near base many, to 40 by hardly 1 mm, rigidly erect, twisted, dark with very narrow paler edges. Lower *pinnae* gradually reduced, lowest 12 cm long, longest 24 cm. Largest *pinnules* 45 by 10 mm, very rigid, shape and texture about as in *C. muelleri*, differing in having veins prominent on both surfaces. *Sori* at first completely covered by firm indusia which break irregularly and persist. *Scales and hairs*: most scales on pinna-rachis and costae soon caducous, remaining larger ones light brown, flat, elongate, setiferous, also pale sub-bullate scales  $\frac{1}{2}$  mm long and wide; costules usually bare; veins bearing minute hairs on lower surface.

Type specimen: BRASS 9430, Mt Wilhelmina, W. New Guinea (A; dupl. at L, BO, MICH, UC).

Distr. *Malaysia*: W. New Guinea (one collection).

Ecol. At 3200 m.

**55. *Cyathea archboldii* C. CHR.** Brittonia 2 (1937) 278; COPEL. Philip. J. Sc. 77 (1947) 105.—*C. bidentata* COPEL. Un. Cal. Publ. Bot. 18 (1942) 218; Philip. J. Sc. 77 (1947) 105, pl. 3.



Fig. 15. *Cyathea pseudomuelleri* HOLTUM (BRASS 9430), showing habit and persistent stipe-bases throughout trunk. Mt. Wilhelmina, W. New Guinea, 3200 m (L. J. BRASS).

*Fronds* 200–300 cm long, about 10. *Stipe* c. 50 cm, base bearing short spines and covered with scales; largest scales 30–40 by  $1\frac{1}{2}$ –2 mm, very pale to

pale brownish with fragile edges which may be darker than the rest; also present a rather close thin layer of rusty brown scurf consisting of very small irregular scales mostly bearing 1 or more dark flexuous setae; *rachis* similarly covered with small scales, sometimes also with narrow scales to 10 mm long. Largest *pinna* 45 cm long. Largest *pinnules* 60–90(–120) by 13–20(–25) mm, sessile, several basal pairs of segments separately adnate to costa; costules 3–5 mm apart; veins to 9 pairs; lamina-segments rather thick and rigid, crenate-serrate, basal ones lobed up to  $\frac{1}{2}$  way to costule, lobes retuse or bidentate. *Sori* near costules; indusium at first covering sorus, sometimes opening by a small apical circle, soon breaking irregularly, persistent. *Scales and hairs*: pinna-rachis, costa and costules covered with scales like the small ones on the stipe, those on costules with many long flexuous shining marginal setae, none bullate; small dark setiferous scales also present on lower surface of veins; narrow elongate scales sometimes also present on pinna-rachis and costae.

Type specimen: BRASS 4551, Murray Pass, Wharton Range, Papua (BM; dupl. at A, BO, BRI, MICH).

Distr. Solomon Is (Bougainville), in *Malaysia*: New Guinea.

Ecol. At 1950–2840 m, in forest, in New Guinea; at 1000 m on Bougainville I. The Bougainville specimen is less rigid and small scales generally are pale-fringed, not setiferous. A Papuan specimen from 3000 m, in alpine shrubbery (SCHODDE 1890) is smaller and much more densely scaly throughout than other specimens.

*var. horrida* HOLTUM, *var. nov.*

*A typo speciei differt: paleis stipitis atrocastaneis, spinis ad  $2\frac{1}{2}$  mm longis, paleis venarum paucioribus, non vel raro setiferis.*

Type specimen: HOOGLAND & PULLEN 5506, NE. New Guinea, at 2400 m, in mountain forest (K).

56. *Cyathea foersteri* ROSENST. in Fedde, Rep. 10 (1912) 321; v. A. v. R. Handb. Suppl. (1917) 28; C. CHR. Brittonia 2 (1937) 279; COPEL. Philip. J. Sc. 77 (1947) 104.

*Trunk* to 10 m, bearing 9 fronds 225 cm long (BRASS). *Stipe* 5–15 cm, closely covered throughout with pale scales to 15 by little over 1 mm. Lower *pinnae* gradually reduced, lowest 8 cm long; longest 35 cm. Largest *pinnules* to 90 by 15 mm (on a small frond to 55 by 16 mm), lowest segments (sometimes several pairs) free or distinctly separate and joined by a narrow wing; costules  $2\frac{1}{2}$ – $3\frac{1}{2}$  mm apart; veins 7–10 pairs, dark and raised on lower surface; lamina-segments rather thin, finely crenate-serrate, free basal ones sometimes deeply lobed, lobes bidentate. *Sori* near costules; indusium thin and firm, covering sorus to maturity, breaking and persisting; receptacle swollen; apparently no paraphyses. *Scales and hairs*: pinna-rachis more or less persistently covered with small pale scales which are usually setiferous, also sometimes scattered narrow scales 5 mm or

more long, often with long dark marginal setae; costal scales ovate to elongate, often closely overlapping, edges usually setiferous but the smaller sometimes with a short pale fringe; costular scales as costal but smaller, in some cases smallest ones setiferous, in other cases fringed with short hairs; similar scales more or less abundant on lower surface of veins.

Type specimen: KEYSER 16, Sattelberg, NE. New Guinea (S-PA; dupl. at B).

Distr. *Malaysia*: Eastern New Guinea.

Ecol. In scrub on forest edge and in mossy forest, at 1600–2800 m.

Note. This species is very near *C. archboldii*, but appears to be distinct in its short stipe with reduced lower pinnae, and shorter narrower stipe-scales; also possibly in thinner pinnule-segments. There is a good deal of variation in the abundance of dark setae on the scales of pinna-rachis, costae and costules.

**57. *Cyathea nigrolineata* HOLTUM**, Kew Bull. 16 (1962) 58.

*Fronde* 210 cm or more long, in 1 or 2 whorls of 5–8 each. *Stipe* to 12 cm, not spiny, densely covered throughout with scales to 25 by less than 1 mm, shining and almost white or more usually with a narrow median black line, all ending in a dark seta, fragile edges dull; also a thin under-cover of small dull brown scales, some setiferous. Lower *pinnae* gradually reduced, lowest 5 cm long, longest 35–45 cm (rarely to 60 cm). Largest *pinnules* of type 47 by 12 mm, of another collection 90 by 20 mm, sessile, apex abruptly pointed, several lower pairs of segments partly free (constricted on acroscopic side at base), 1–2 pairs sometimes quite free; costules 2½–3 mm apart; veins 8–10 pairs, concolorous and not raised on lower surface; lamina-segments very firm, edges entire or undulate, not crenate, or those on larger pinnules sometimes lobed where fertile, lobes sometimes bidentate. *Sori* near costules; indusium firm, brown, at first complete, breaking and persistent. *Scales and hairs*: pinna-rachis bearing copious very small brown scales with setiferous apex, also scattered scales 2–3 by ½ mm, with dark shining mid-band and paler edges, and somewhat smaller, narrower scales bearing marginal setae; scales on costae many, small, dark, shining, with many curved dark setae; on costules and veins smaller, those on veins scattered but abundant.

Type specimen: HOOGLAND & PULLEN 5495, Eastern Highlands, NE. New Guinea (K; dupl. at BO, US, SYD, BRI, L).

Distr. *Malaysia*: Eastern New Guinea (4 collections).

Ecol. At 2300–2400 m in forest or secondary growth (specimen from secondary growth is largest). This species should perhaps be united with *C. foersteri* ROSENST. Type material of the latter does not show stipe nor larger scales of pinna-rachis.

**58. *Cyathea inquinans* CHRIST**, Verh. Nat. Ges. Basel 11 (1896) 422; Ann. Jard. Bot. Btzg 15

(1898) 83, t. 13, f. 5; v. A. v. R. Handb. (1908) 23.

*Stipe* 15 cm, densely scaly; larger scales bright red-brown, rather thin, to 30 by 2 mm, long-acuminate, apex a dark red seta, fragile edges narrow; small scales very abundant, often with dark red setiform apex. *Rachis* similarly scaly on lower surface, larger scales to 10 by 1 mm, bearing rather many dark red setae more than ½ mm long. *Pinnules* to 60 by 15 mm, short-acuminate, lobed nearly to costa, close and more or less imbricate; costules 3 mm apart; veins 9 pairs; lamina-segments where fertile rather deeply lobed. *Sori* near costules; indusium thin, brown, at first complete, breaking and persistent. *Scales and hairs*: pinna-rachis scaly as main rachis, small scales very abundant and mostly setiferous; costal scales light brown, all setiferous, grading from elongate acuminate to very small; costular scales as smaller ones on costae; no hairs on lower surface of pinnules.

Type specimen: P. & F. SARASIN 1328, Mt Lompobattang (= Bonthain), SW. Celebes (BAS).

Distr. *Malaysia*: SW. Celebes (2 collections), Moluccas: Ceram (?).

Ecol. At 2000–2800 m.

Note. A sterile specimen collected by EYMA in Ceram (*n.* 2371) agrees with *C. inquinans* in scaliness, but is larger, apparently with a longer stipe; it has pinnae to 60 cm long, pinnules to 100 by 20 mm, costules 4 mm apart, veins 15 pairs. If not *C. inquinans*, it probably represents a new species. The altitude given for this specimen is 40 m, but EYMA had just descended from the mountains and it seems possible that the specimen was collected there.

**59. *Cyathea ferruginea* CHRIST**, Philip. J. Sc. 2 (1907) Bot. 181; v. A. v. R. Handb. (1908) 784; COPEL. Fern Fl. Philip. 2 (1960) 215.—*C. ferrugineoides* COPEL. Philip. J. Sc. 81 (1952) 15; Fern Fl. Philip. 2 (1960) 215.

*Stipe* 12 cm, bearing many spines 1 mm long; scales rather sparse, to 15 by 1 mm, dark with narrow pale fragile edges bearing setae. Lowest *pinnae* 5–6 cm long, possibly a gap between these and next pinnae; longest pinna 35 cm or more. *Pinnules* to 80 by 15–20 mm, lower ones on stalks 2–4 mm long, acuminate, lobed nearly to costa; costules 3½–4½ mm apart; veins to 9 pairs; lamina-segments thin to firm, slightly crenate; fertile pinnules narrower than sterile, with closer costules. *Sori* near costules; indusium at first complete, thin, pale, breaking irregularly and persistent; paraphyses many, as long as or longer than sporangia, not widened at base. *Scales and hairs*: pinna-rachis glabrescent on lower surface, residual scales mostly very narrow, on distal part some scales as costae and also slender crisped hairs; scales near base of costae narrow, flat, entire, grading to paler acuminate bullate scales; bullate scales on costules.

Type specimen: FOXWORTHY BS 560, Palawan (P; dupl. at BO, K, US, MICH, A).

Distr. *Malaysia*: Philippines (Palawan, Balabac, Negros).



Ecol. In forest, to 1150 m, the type from mossy forest, near summit of Mt Pulgar, other specimens apparently from lower altitudes.

**60. *Cyathea oosora*** HOLTUM, Kew Bull. 16 (1962) 59.—*C. assimilis* [non HOOK.] CHRIST, Ann. Jard. Bot. Batz 15 (1898) 82.

*Stipe* 50 cm or more, warty near base; pneumathodes 14–20 mm long, in an almost continuous row; scales not seen. Longest *pinnae* 60 cm long. Largest *pinnules* 90 by 20 mm, sessile or nearly so, acuminate, lobed almost to costa, lowest segment not free; costules  $3\frac{1}{2}$ –4 mm apart; veins 9–10 pairs; lamina-segments rigid, edges crenate. *Sori* near costules; indusium firm, shining brown when old, at first ovoid with a small apical aperture, breaking irregularly and persistent; paraphyses short, slender. *Scales and hairs*: pinna-rachis glabrescent on lower surface, residual scales 3–4 mm long, narrow, brown, crisped, not setiferous; costae densely scaly, scales uniformly brown, lower ones elongate-acuminate with slightly bullate base, grading to hair-pointed bullate scales distally and on costules; some of the larger costal and costular scales have marginal concolorous hairs, not dark setae.

Type specimen: CLEMENS 51188, Mt Kinabalu, N. Borneo (K; dupl. at A, L, MICH, UC).

Distr. *Malaysia*: N. Borneo, N. Celebes.

Ecol. At 2200–3000 m in ridge-forest, on Mt Kinabalu; at 1500–2000 m in Celebes.

Note. The Celebes specimens differ from those on Mt Kinabalu in having paler scales, and one of them (SARASIN 933) has very few scales on the pinnules.

**61. *Cyathea halconensis*** CHRIST, Philip. J. Sc. 3 (1908) Bot. 270; COPEL. Philip. J. Sc. 4 (1909) Bot. 51; v. A. v. R. Handb. Suppl. (1917) 24; COPEL. Fern Fl. Philip. 2 (1960) 216.—*C. mearnsii* COPEL. Philip. J. Sc. 3 (1909) Bot. 356; *ibid.* 4 (1909) Bot. 57; v. A. v. R., Handb. Suppl. (1917) 24; COPEL. Fern Fl. Philip. 2 (1960) 214.—*C. melanophlebia* COPEL. Philip. J. Sc. 38 (1929) 131; Fern Fl. Philip. 2 (1960) 220.

*Stipe* commonly 5 cm, spines copious, conical, to 1 mm long; scales to 30 by 2 mm, dark brown, hardly shining, with distinct concolorous fragile edges bearing a few dark setae. Lower *pinnae* gradually reduced, lowest 7–12 cm long, sometimes bipinnate; longest pinna 50 cm. Largest *pinnules* commonly 70–100 by 20 mm wide at base, sessile, caudate-acuminate (cauda to 15 mm), lowest 1–3 pairs of segments free or nearly so, rest of pinnule lobed almost to costa; costules  $3\frac{1}{2}$ –4½ mm apart; veins to 12 pairs; lamina-segments thin but firm, crenate. *Sori* near costules, quite covered when young by rather thin pale indusia which break and persist; receptacle swollen; paraphyses short, some apical ones with a broad base. *Scales and hairs*: pinna-rachis rather pale, glabrescent, sparsely warty, residual scales narrow, bearing a few setae; scales on costae and costules few, thin, brown, ovate or narrower, entire, flat; minute hairs on veins abundant and often conspicuous.

Type specimen: MERRILL 6055, Mt Halcon, Mindoro, Philippines (P; dupl. at US, MICH, A).

Distr. *Malaysia*: Philippines (Mindoro, Luzon).

Ecol. Probably in forest, at 1200–1700 m.

Note. The wide pinnules are a character of this species; on the type collection are pinnules only 65 by 20 mm. COPELAND reported pinnules 29 mm wide on the type of *C. mearnsii*, but I found none larger than 110 by 23 mm.

**62. *Cyathea ascendens*** DOMIN, Acta Bot. Bohem. 9 (1930) 94.—*Alsophila rosenstockii* BRAUSE, Bot. Jahrb. 56 (1920) 63; COPEL. Philip. J. Sc. 77 (1947) 116.

*Trunk* slender; fronds to 100 cm long, well spaced, with long-decurrent bases. *Stipe* 8–12 cm; scales on stipe and lower part of rachis to 8 by 1 mm, dark and shining with fragile pale edges bearing long flexuous dark setae. *Pinnae* 35–40 pairs, lower ones gradually reduced, longest  $8\frac{1}{2}$  by  $1\frac{3}{4}$  cm, almost sessile, pinnatifid nearly to costa; costules of pinna-segments  $4\frac{1}{2}$  mm apart (fertile) to  $5\frac{1}{2}$  mm (sterile); veins to 10 pairs, simple or forked. *Sori* median; no indusia. *Scales and hairs*: main rachis beneath covered with copious crisped dark hairs, with a few scales attached to wart-like bases, scales very narrow, to 3–4 mm long, brown with irregular long flexuous marginal setae; costae of pinnae similarly hairy and scaly beneath; costules of pinna-segments bearing paler and sparser hairs on lower surface and a few small scales; no bullate scales seen.

Type specimen: LEDERMANN 9963, Sepik Region, NE. New Guinea (B).

Distr. *Malaysia*: NE. New Guinea (2 collections).

Ecol. In forest, at 800–1000 m.

Notes. The collector wrote of the trunk '1–2 m lang, krumm'. The herbarium specimen shows the apex of the trunk, 14 cm long, straight, lacking roots. There is no evidence of climbing habit; it seems more likely that the slender trunk had fallen, or partly fallen, and that the apical part grew erect after the fall, the whole being thus crooked. This species seems nearest to *C. gregaria*, but, apart from the simply pinnate condition, the rachises are far more hairy on the lower surfaces.

**63. *Cyathea recurvata*** (BRAUSE) DOMIN, Acta Bot. Bohem. 9 (1930) 153.—*Alsophila recurvata* BRAUSE, Bot. Jahrb. 56 (1920) 61.

*Trunk* to 5 m; fronds of type not over 150 cm long (*sec. coll.* 200 cm). *Stipe* 10 cm; scales medium brown, to 12 by  $1\frac{1}{2}$ , their fragile edges bearing dark setae; pneumathodes 4 mm long, well-spaced. Lower *pinnae* gradually reduced, lowest 4 cm long, longest 20 cm. *Pinnules* to 28 by 8 mm wide at base, rather suddenly contracted to 5–6 mm wide, lobed to about half-way to costa; costules  $2\frac{1}{2}$  mm apart; veins to 5 pairs in basal segments, in others 3 pairs, simple except in basal segments. *Sori* near costules; no indusium; receptacle rather elongate; paraphyses short. *Scales and hairs*: lower surface of pinna-rachis bearing narrow setiferous scales to 2 mm long and crisped

dark hairs; costae similar; no scales seen on costules (all pinnules of type are fully fertile).

Type specimen: LEDERMANN 9264, Sepik Region, NE. New Guinea (B).

Distr. *Malaysia*: NE. New Guinea (one collection).

Ecol. At 850 m.

**64. *Cyathea eriophora* HOLTUM**, Kew Bull. 16 (1962) 55.

*Trunk* to 3 m; fronds few, to 225 cm long.

*Stipe* 15 cm, dark, with spines to 1 mm long, covered throughout with a close felt of very small pale scales, the larger with dark setiform apex; large scales abundant on stipe and base of rachis, to 20 by 2 mm, narrowed to twisted tip, shining dark brown with narrow fragile edges bearing many long dark setae. Lower surface of *main rachis* smooth, medium brown, with dense felt of pale crisped hairs and scattered long narrow dark setiferous scales. Lower *pinnae* gradually reduced, lowest 5–8 cm long, longest 30–42 cm. *Pinnules* to 75 by 18 mm, sessile, short-acuminate, lowest segment almost free, rest of pinnule lobed nearly to costa; costules 3–3½ mm apart; veins 8–9 pairs; lamina-segments rather thin, almost entire or lowest ones on lower pinnules deeply crenately lobed. *Sori* near costules, without indusia; receptacle swollen; paraphyses short. *Scales and hairs*: lower surface of pinna-rachis densely covered with long tangled pale crisped hairs, also many narrow dark scales with pale edges bearing long setae; costae similar; costules bearing pale bullate scales, usually hair-pointed; upper surface of pinna-rachis and costae covered with dark hairs, also on pinna-rachis some scales as on lower surface.

Type specimen: CARR 14439, Boridi, Papua (K; dupl. at BM, L).

Distr. *Malaysia*: Eastern New Guinea (3 collections).

Ecol. In wet ravine in forest, locally common, at 1400–1950 m.

**65. *Cyathea gregaria* (BRAUSE) DOMIN**, Acta Bot. Bohem. 9 (1930) 120.—*Alsophila gregaria* BRAUSE, Bot. Jahrb. 56 (1920) 68.

*Trunk* 4–5 m, 'arm-thick'. *Stipe* 40 cm; spines to 1 mm long; scales few, to 15 by 1 mm, medium brown with pale edges bearing long flexuous setae. Lowest *pinna* 17 cm long, longest 32 cm. *Pinnules* to 60 by 15 mm, lobed almost to costa; costules 3½ mm apart; veins to 9 pairs; lamina-segments crenate, sinuses rather wide. *Sori* near costules, without indusia; receptacle rather high. *Scales and hairs*: lower surface of pinna-rachis bearing rather sparse dark crisped hairs; on lower surface of costae dark crisped hairs and some dark narrow scales with scattered marginal setae; on costules similar hairs and a few scales.

Type specimen: LEDERMANN 8596, Sepik Region, NE. New Guinea (B).

Distr. *Malaysia*: Eastern New Guinea (one collection).

Ecol. In forest, growing in groups, 100 m.

**66. *Cyathea modesta* (BAK.) COPEL.** Philip. J. Sc. 4 (1909) Bot. 48.—*Alsophila modesta* BAK. J. Bot. 18 (1880) 210; v. A. v. R. Handb. (1908) 37.—*Hemitelia singalanensis* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 16 (1914) 15; Handb. Suppl. (1917) 43.—*Hemitelia confluens* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 16 (1914) 14; Handb. Suppl. (1917) 49.—*Hemitelia subconfluens* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 28 (1918) 25.—*C. singalanensis* DOMIN, Pterid. (1929) 264.—*C. confluens* DOMIN, l.c. 263.—*C. subconfluens* DOMIN, Acta Bot. Bohem. 9 (1930) 162.

*Stipe* 35–50 cm or more; spines bluntly conical, hardly 1 mm high; scales abundant throughout, to 30 by 1½ mm, medium brown with narrow concolorous fragile edges; also more or less abundant hairs at rachis. Main *rachis* covered with a close felt of crisped pale hairs, also with more or less caducous very narrow entire crisped brown scales 5–10 mm long. *Pinnae* to 40 cm or more long. *Pinnules* to 60 by 14 mm, sessile, abruptly pointed, one to several basal segments almost free; costules 3–4 mm apart; veins 7–10 pairs; lamina-segments firm, crenate, or the basal ones more deeply lobed, sinuses (apart from basal ones) narrow. *Sori* near costules; indusium hemitelioid, firm, brown, sometimes semicircular, or smaller and a little bilobed, hidden or almost hidden by ripe sorus; paraphyses as long as sporangia, sometimes widened at base. *Scales and hairs*: pinna-rachis densely covered throughout with crisped hairs, very narrow crisped entire brown scales at first abundant, also distally smaller scales bullate at base; at base of costae narrow acuminate entire scales, flat or bullate at base, grading to bullate-acuminate scales, some of which occur throughout costa; scales on costules bullate, often hair-pointed.

Type specimen: BECCARI 434, G. Singgalang, Sumatra (K; dupl. at FI).

Distr. *Malaysia*: Sumatra.

Ecol. In forest at 1800–2400 m.

Note. The type of *Alsophila modesta* was an unusually small specimen, with pinnules to 40 by 11 mm.

**67. *Cyathea doctersii* v. A. v. R.** Bull. Jard. Bot. Btzig III, 2 (1920) 136.

*Stipe*-base not seen. Main *rachis* and pinna-rachis glabrous on the median raised part of the upper surface (some hairs present in the small groove on each side of this), hairy throughout on lower surface. *Pinnae* to 45 cm long. *Pinnules* to 75 by 17 mm, lobed almost to the costa, almost sessile, shortly pointed; costules 3½–4 mm apart; veins to 8 pairs; lamina-segments almost entire. *Sori* near costules; indusium a thin brown scale of varied shape and size on costular side, often 2-lobed, sometimes encircling the base of the receptacle. *Scales and hairs*: scales near base of costae elongate, entire, flat, grading to similar scales bullate at the base and to bullate-acuminate; hairs also present on lower surface of costae, not on upper surface.

Type specimen: DOCTERS VAN LEEUWEN 3265, Deli, Sumatra (BO; dupl. at L).



Distr. *Malaysia*: Sumatra (one collection).

Ecol. Probably in forest, at 150 m.

Note. This is near *C. javanica* in character and distribution of hairs and scales, but almost all indusia are hemitelioid; it is possibly a hybrid between *C. javanica* and one of the species of the *C. latebrosa* alliance.

**68. *Cyathea cucullifera* HOLTUM**, Kew Bull. 16 (1962) 54.

*Fronds* 150–175 cm long, in 2 whorls of 4–6 each. *Stipe* 15 cm, warty, densely scaly throughout; larger scales all round base of stipe, along sides above base, to 20 by  $\frac{1}{2}$  mm, dark, shining, with narrow pale edge bearing scattered long flexuous dark setae; small scales forming a dense felt over whole abaxial surface of stipe, dark brown, larger ones setiferous; *rachis* pale brown, finely warty, with sparse covering of very small pale brown scales. Lower *pinnae* gradually reduced, lowest less than 5 cm long, largest 30 cm. *Pinnules* to 40 mm long and 10 mm wide (sterile), 6–8 mm wide (fertile), sessile, short-acuminate, lobed nearly to costa, lowest segment not quite free; costules 3 mm apart (sterile), 2–2½ mm (fertile); veins 8–9 pairs (sterile), 6 pairs (fertile); lamina-segments firm, close, nearly entire. *Sori* close to costule; indusium a pale brown scale backing the costule, concave towards sorus, when flattened usually more than a semicircle (rarely spreading round base of receptacle); paraphyses slender, short. *Scales and hairs*: lower surface of pinna-rachis covered with interlacing crisped hairs and very small scales with a crisped hair-tip, also scattered elongate flat scales bearing a few long marginal setae; at base of costae some (usually deciduous) narrow setiferous scales, also very small pale scales, some with long flexuous hair-tips, grading to crisped hairs and to very small scales, distally to small pale bullate scales; on costules very small pale hair-tipped scales and pale bullate scales; on veins abundant very short appressed hairs (bases of scales?).

Type specimen: HOOGLAND & PULLEN 5497, Eastern Highlands, NE. New Guinea (K; dupl. at L, BO, US, SYD, BRI).

Distr. *Malaysia*: E. New Guinea (4 collections).

Ecol. Common in mountain forest, at c. 2400 m.

**69. *Cyathea setulosa* COPEL**, Philip. J. Sc. 81 (1952) 14; Fern Fl. Philip. 2 (1960) 212.

*Stipe* not known. *Pinnae* 45 cm long. Largest *pinnules* 90 by 17 mm, sessile, shortly caudate, basal 1–2 segments free, then 1–2 pairs separately adnate to costa, rest of pinnule lobed nearly to costa; costules 3½ mm apart; veins 9–11 pairs; lamina-segments almost entire except the lower fertile ones which are sometimes deeply crenate near base. *Sori* near costules; indusium dark brown hemitelioid, more than half covering mature sorus, at length reflexed and backing the costule; paraphyses short. *Scales and hairs*: lower surface of pinna-rachis densely covered with dark shining crisped hairs, with a few dark very narrow entire scales; costae hairy beneath as pinna-rachis except near apex, scales few, small, not setiferous;

no bullate scales seen on costae and costules.

Type specimen: ALCASID & EDANO, PNH 5068, Mt Camatis, Quezon Province, Luzon (UC).

Distr. *Malaysia*: Philippines (Luzon).

**70. *Cyathea muelleri* BAK.** J. Bot. 28 (1890) 104; v. A. v. R. Handb. (1908) 25; COPEL, Philip. J. Sc. 77 (1947) 105.—*C. longipaleata* ALSTON, J. Bot. 78 (1940) 226; Nova Guinea n.s. 4 (1940) 110, t. 4, f. 2, t. 5, f. 3.—**Fig. 16.**

*Trunk* to 10 m, 15–20 cm  $\phi$ , bearing fronds in whorls of 10–12, usually 2 whorls present; fronds c. 100 cm long, apices upcurved. *Stipe* 10–12 cm; spines to 1 mm long; scales rigid,  $\pm$  twisted, 50 by 1½ mm, shining brown, fragile edges very narrow. Lower *pinnae* gradually reduced, lowest 4–5 cm long; longest pinna 20 cm. Largest *pinnules* 40–50 by 10–16 mm, sessile, shortly pointed, lowest 1–2 segments free, then c. 3 pairs constricted at base on acroscopic side and decurrent on basispic side; costules 3–3½ mm apart; veins 7 pairs, flat or slightly grooved on both surfaces; lamina-segments very rigid, edges slightly reflexed and minutely crenate, or lower ones distinctly lobed if fertile. *Sori* usually to 6 pairs on a segment; indusium very firm, brown, almost covering sorus to maturity but open on side remote from costule; receptacle swollen, sporangia very numerous; paraphyses short, slender. *Scales and hairs*: pinna-rachis glabrescent and finely warty; scales on costae and costules early caducous, some residual scales on costae broad and flat, some very narrow and setiferous; costules of sterile pinnules sometimes bearing dark brown entire ovate convex to almost bullate scales.

Type specimen: W. MCGREGOR 62, Mt Knutsford, Papua (K; dupl. at BM, MEL).

Distr. *Malaysia*: New Guinea.

Ecol. At 3500–3600 m, 'common in marginal scrub of subalpine forest and drier more sheltered grass slopes; one or several stems from a common base' (BRASS).

**71. *Cyathea oinops* HASSK.** in Hook. J. Bot. Kew Misc. 7 (1855) 322; Obs. Fil. Jav. 1 (1856) 23; v. A. v. R. Handb. (1908) 25; Suppl. (1917) Corr. 43; BACKER & POSTH. Varenfl. Java (1939) 25, p.p.—*C. oligocarpia* JUNGH. Nat. Geneesk. Arch. N.I. 2 (1845) 39 (*non* KUNZE, 1834).—*C. zollingeriana* (*non* METT.) v. A. v. R. Handb. (1908) 20, 785; Suppl. (1917) 26, Corr. 42.—*C. crenulata* f. *squamulosa* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 20 (1915) 10; Handb. Suppl. (1917) 27, Corr. 63.—*C. crenulata* f. *latissima* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 28 (1918) 11; Handb. Suppl. (1917) Corr. 64.—*C. faberiana* DOMIN, Acta Bot. Bohem. 9 (1930) 114.—**Fig. 8a, 9d.**

*Stipe* c. 35–60 cm, sometimes with a pair of small *pinnae* near base, dark, warty, base covered with firm pale scales to 35 by 3 mm, rest with  $\pm$  abundant very small scurfy scales or glabrescent. Lower *pinnae* more or less reduced, longest 40–55 cm long. Largest *pinnules* 70–100 by 15–20 mm wide just above base, sessile, shortly acuminate, basal segments largest, 2–3 pairs often

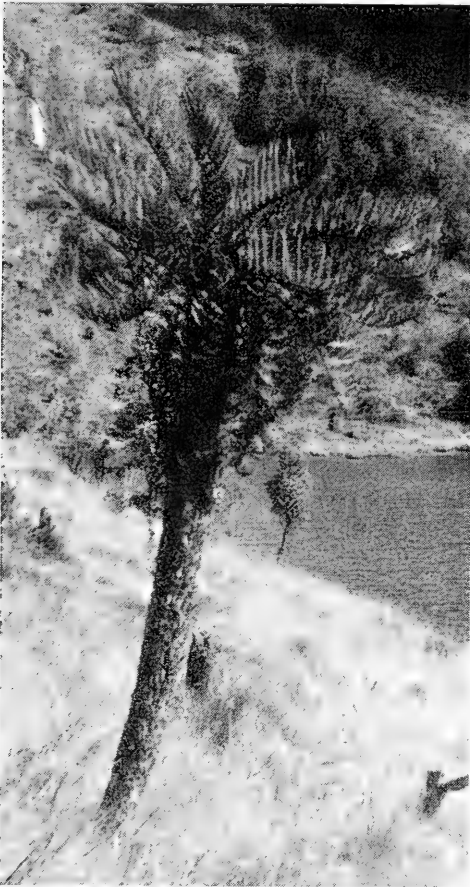


Fig. 16. *Cyathea muelleri* BAK. (HOOGLAND 5707). Mt Wilhelm, Eastern Highlands, E. New Guinea, 3200 m (R. D. HOOGLAND).

separately adnate to costa; costules 3–4 mm apart; veins 10–12 pairs; lamina-segments firm, where sterile finely crenate-serrate, where fertile lobed  $\frac{1}{3}$  or more towards costule, lobes bidentate. *Sori* near costules; indusium firm, brown, covering the sorus almost to maturity but open on side remote from costule; paraphyses slender, shorter than sporangia. *Scales and hairs*: pinna-rachis more or less glabrescent, finely warty, often with a persistent covering of very small, dull, pale brown irregularly short-fringed scales, with some scattered larger elongate scales; costal scales abundant, often closely overlapping, elongate, brown with pale thinner edges bearing scattered dark setae especially near apices, also smaller thin pale fringed scales; on costules thin brown short-fringed scales, ovate to narrower and acuminate, almost flat to convex, sometimes with a few setae.

Type specimen: HASKARL, Mt Gedeh, W. Java (BO; dupl. at L).

Distr. *Malaysia*: Sumatra, Java, Lesser Sunda Is (Lombok), SW. Celebes.

Ecol. At 2000–2500 m, in forest (specimen from Lombok in *Casuarina* forest).

Note. In Fl. Btzg 1 (1898) 36, RACIBORSKI described a species under the name *Cyathea sinops* HASSK., which appears to have been a misprint for *oinops*. RACIBORSKI's specimen was, however, from an unusually large frond of *C. crenulata* BL., which see for further references.

72. *Cyathea loheri* CHRIST, Bull. Herb. Boiss. II, 6 (1906) 1007; v. A. v. R. Handb. (1908) 787; TAGAWA, Act. Phytotax. Geobot. 14 (1951) 94; COPEL. Fern Fl. Philip. 2 (1960) 211.—*C. fructuosa* COPEL. in Elmer, Leaf. Philip. Bot. 2 (1908) 419; v. A. v. R. Handb. Suppl. (1917) 37; COPEL. Fern Fl. Philip. 2 (1960) 207.—*C. mitrata* COPEL. Philip. J. Sc. 3 (1909) Bot. 354; *ibid.* 4 (1909) Bot. 42; v. A. v. R. Handb. Suppl. (1917) 37; COPEL. Fern Fl. Philip. 2 (1960) 211.—*C. campbellii* COPEL. Philip. J. Sc. 38 (1929) 132; Fern Fl. Philip. 2 (1960) 210.—*C. korthalsii* (non METT.) C. CHR. Gard. Bull. S. S. 7 (1934) 222.—*C. indusiosa* COPEL. Philip. J. Sc. 81 (1952) 14; Fern Fl. Philip. 2 (1960) 211.

Trunk to 10 m. *Stipe* short; scales to 25 by  $1\frac{1}{2}$ –3 mm, pale, firm, their fragile edges bearing scattered long dark setae; pneumathodes to 11 mm long, in one row. Lower *pinnae* gradually reduced, lowest c. 7 cm long; longest *pinnae* to 40 cm or more. Largest *pinnules* 75–95 by 15–19 mm, sessile, short-acuminate, lowest 1–4 segments more or less contracted at base, rest of *pinnule* lobed nearly to costa; costules  $3\frac{1}{2}$ –4 mm apart; veins 10–12 pairs; lamina-segments firm, crenate or the larger ones more deeply lobed where fertile. *Sori* near costules; indusium firm, shining brown to purplish, almost covering sorus to maturity but open on side remote from costule, more or less breaking when old. *Scales and hairs*: pinna-rachis finely warty, at first densely scaly, many scales usually persistent; small ones rusty, dull, short-fringed, larger ones pale with some dark setae; on costae many scales, lower ones rather pale brown, acuminate with setae or hairs on edges, grading to numerous bullate scales; bullate scales, sometimes with dark setae, present on costules.

Type specimen: LOHER *s.n.*, 7 Jan. 1906, Mt Banajao, Luzon (not found at P; dupl. at S-PA).

Distr. *Formosa*, in *Malaysia*: Philippines (Luzon, Negros, Mindanao), N. Borneo.

Ecol. In forests, 600–2500 m.

Notes. This species is closely allied to *C. oinops*, but differs in bullate scales and apparently in the lower *pinnae* always gradually reduced. Young plants (as seen by me on Mt Kinabalu) have long-stalked fronds. Possibly *C. oinops* and *C. loheri* should be united; *C. oinops* is the older name.

73. *Cyathea cinerea* COPEL. in Elmer, Leaf. Philip. Bot. 5 (1913) 1681; v. A. v. R. Handb. Suppl. (1917) 36; COPEL. Fern Fl. Philip. 2 (1960) 215.

Trunk 5 m, 12 cm  $\sigma$ . *Stipe* bearing spines 8 mm

long (*vide* COPEL., not seen); length of stipe not recorded. Main *rachis* spiny near base, spines to 3 mm long. *Pinnae* to 55 cm long. Largest sterile *pinnules* 90 by 18 mm, fertile 13 mm wide, sessile, acuminate, lobed almost to costa, basal segment not free; costules 3–3½ mm apart; veins 12 pairs; lamina-segments firm, crenate-serrate, sterile ones close, fertile narrower and separated by sinuses 1 mm wide. *Sori* near costules; indusium almost covering sorus to maturity but open on side remote from costule; paraphyses short, slender. *Scales and hairs*: pinna-rachis pale, with a few slender spines ½ mm long, persistently but sparsely covered with irregular pale scales less than 1 mm long and a few narrow entire brown scales to 3 mm long; scales on costae dull brown, flat, elongate, rarely with a few long dark setae, also very small scales as on pinna-rachis; on costules (of sterile pinnules) pale entire bullate-acuminate scales.

Type specimen: ELMER 13860, Mt Urdaneta, Agusan Province, Mindanao (US; dupl. at MICH, K, BO, P, A, UC, L, U, BM).

Distr. *Malaysia*: Philippines (Mindanao, one collection).

Ecol. At 1050 m.

**74. *Cyathea pachyrrhachis* COPEL.** Un. Cal. Publ. Bot. 18 (1942) 218; Philip. J. Sc. 77 (1947) 107, pl. 5.

*Trunk* to 7 m, 7½ cm ø, stipe-bases not persistent, scars in alternate whorls of 5; fronds 10 (or 5), 150–300 cm long. *Stipe* 30–40 cm, copiously warty; scales pale or partly dark, to 20 by 1 mm, with narrow fragile edges, not setiferous, also very small dull pale irregular scales. Lowest *pinnae* 20–25 cm long, longest 40–60 cm. Largest *pinnules* 60–100 by 15–20 mm, sessile, acuminate, 1–2 pairs basal segments free, rest of pinnule lobed nearly to costa; costules 3–4 mm apart; veins to 12 pairs (sterile), 9 pairs (fertile); lamina-segments very firm, sterile ones crenate, fertile rather deeply lobed, lobes bifid; sterile segments contiguous, fertile separated by sinuses. *Sori* near costules; indusium firm, covering sorus to maturity but open on side remote from costule, breaking somewhat when old. *Scales and hairs*: pinna-rachis more or less glabrescent, residual scales setiferous, very small with a few elongate narrow dark ones; costae rather densely scaly near base, some scales to 3 mm long, narrow, very dark, shining, with thin pale edges bearing a few setae near apices, grading to entirely pale setiferous scales, smaller ones all flat, ovate to nearly circular; similar scales on costules and rarely also on veins.

Type specimen: BRASS 12118, Idenburg River, W. New Guinea (MICH; dupl. at BO, BM, UC, L, A).

Distr. *Malaysia*: New Guinea (several collections), d'Entrecasteaux Is (Goodenough I.).

Ecol. In forest, 1000–2850 m. A specimen from secondary *Nothofagus* forest at 2060 m (BRASS 29674) has small fronds (pinnules 60 mm long), the smaller scales all strongly dark-setiferous, including those on veins, the latter being abundant, another (30316) from mossy forest at 2770 m, had

fronds of similar size, scales on veins rarely setiferous; BRASS 30668, from 2850 m, has the broadest pinnules, with several pairs of basal segments almost free.

**75. *Cyathea latipinnula* COPEL.** in Elmer, Leaf. Philip. Bot. 4 (1911) 1149; Fern Fl. Philip. 2 (1960) 226.—*Hemitelia latipinnula* v. A. v. R. Handb. Suppl. (1917) 52.

*Trunk* 120 cm, 10 cm ø; fronds 180 cm long. *Stipe* 60 cm long (*vide* COPEL.), scales not seen; main rachis glabrescent, bearing numerous spines less than 1 mm long. *Pinnae* to 40 cm long. *Pinnules* to 120 by 40 mm, caudate-acuminate, lower ones somewhat shorter and on stalks to 7 mm long, lowest 1–2 segments of larger pinnules quite free, next 1–2 pairs constricted at base; costules 5–6 mm apart; veins to 12 or more pairs, basal basicopic vein of each group attached at very base of costule; lamina-segments very firm, tapering and crenate towards apices, free basal ones sometimes deeply lobed. *Sori* near costules; indusium hemitelioid, small, dark, outer edge uneven, not reaching costule and hidden by mature sorus; receptacle swollen; paraphyses as long as sporangia, some several cells wide at base. *Scales and hairs*: pinna-rachis minutely spiny, also bearing short crisped hairs and a few residual narrow brown scales which may be setiferous; a few narrow scales at base of costae, most being ovate-acute, grading to bullate; entire bullate scales on costules.

Type specimen: ELMER 12512, Sibuyan Island (MICH; dupl. at US, K, FI, P, A, SYD, BO, BM).

Distr. *Malaysia*: Philippines (Sibuyan Island, one collection).

Ecol. On windy ridge at 1400 m.

**76. *Cyathea masapilidensis* COPEL.** Philip. J. Sc. 81 (1952) 17; Fern Fl. Philip. 2 (1960) 227.

*Stipe* rather slender, bearing close sharp slender spines to 5 mm long; scales not seen. Lower *pinnae* unknown; middle *pinnae* 50 cm long. Largest *pinnules* 65–80 by 16–18 mm, acuminate, on stalks to 6 mm long, lobed almost to costa, lowest segment sometimes free; costules 3½ mm apart; veins 10 pairs; lamina-segments very firm, nearly entire. *Sori* near costules; indusium thin, dull brown, covering about half of sorus at maturity, hemitelioid. *Scales and hairs*: pinna-rachis glabrescent, residual scales very narrow, dark, with long marginal setae; scales on costae sparse, flat, brown with pale margins bearing some setae, grading to very small flat scales; no costular scales seen, and none bullate.

Type specimen: RAMOS & EDANO, BS 37858, Mt Masapilid, Bontoc Subprov., Luzon (MICH; dupl. at US, BO).

Distr. *Malaysia*: Philippines (Luzon, 2 collections).

**77. *Cyathea loerzingii* HOLTUM,** Kew Bull. 16 (1962) 58.

*Stipe* at least 40 cm, rather sparsely warty near base; persistent scales few, to 20 by 2½ mm, shining dark brown with rather broad paler fragile

edges; pneumathodes 10–15 mm long, in an irregular double row. *Pinnæ* probably to 50 cm long (only upper ones seen). *Pinnules* to 100 by 18 mm, lowest on stalks to 7 mm long, apex acuminate, lowest 1–2 segments not free but on larger pinnules separated by a narrow wing from the rest; costules 4 mm apart; veins 10–11 pairs; lamina-segments firm, drying very dark on upper surface, edges finely crenate, lowest ones not deeply lobed. *Sori* near costules; indusium at maturity firm, brown, semicircular, reflexed against costule, c. 1 mm wide; receptacle swollen, bearing at its apex a small group of scales 4–5 cells wide (bases of paraphyses?), other paraphyses short, slender. *Scales and hairs*: lower surface of pinna-rachis smooth, glabrescent; scales near bases of costae elongate, shining brown with a few hairs or dark setae on margins, grading to acuminate bullate-based scales distally; on costules brown bullate scales, often acuminate.

Type specimen: LÖRZING 14904, Mt Sibajak, Sumatra (L; dupl. at BO).

Distr. *Malaysia*: Sumatra (one collection).

Ecol. In forest at 1300–1400 m.

**78. *Cyathea rufopannosa*** CHRIST, Philip. J. Sc. 2 (1907) Bot. 180; v. A. v. R., Handb. (1908) 784; COPEL. Fern Fl. Philip. 2 (1960) 212.

*Trunk* (dry) 4 cm ø. *Stipe* 40–50 cm, sometimes with a pair of small pinnæ near base; base warty; scales 15 by 2 mm, castaneous or paler, fragile edges narrow. Largest *pinnæ* 37 cm long. *Pinnules* to 65 by 13–15 mm, sessile, short-acuminate, several pairs of lower segments contracted at base, lowest 1–3 quite free; costules  $2\frac{1}{2}$ –3 mm apart; veins 8 pairs; lamina-segments firm, crenate. *Sori* near costules; indusium hemitelioid, more than a semicircle, covering costular side of sorus at maturity; receptacle rather slender; paraphyses long, often broad at the base. *Scales and hairs*: pinna-rachis densely and persistently scaly beneath; scales of all sizes, largest 6 by 1 mm, flat, entire, light brown, smaller ones bullate at base; at bases of costae many elongate flat light brown entire scales, grading to bullate (some bullate to base of costa); bullate scales on costules.

Type specimen: COPELAND 1730, San Ramon, Mindanao (P; dupl. at MICH); also from same locality COPELAND 1735 (P, US, SYD, S-PA).

Distr. *Malaysia*: Philippines (Mindanao).

Ecol. Probably in forest, 1200 m.

**79. *Cyathea callosa*** CHRIST, Bull. Herb. Boiss. II, 6 (1906) 1008; v. A. v. R., Handb. (1908) 787; COPEL. Fern Fl. Philip. 2 (1960) 222, *excl. syn. Hemitelia caudiculata* ROSENST.—*C. foxworthyi* COPEL. Philip. J. Sc. 3 (1909) Bot. 355; v. A. v. R., Handb. Suppl. (1917) 35; COPEL. Fern Fl. Philip. 2 (1960) 220.—*C. camaguinensis* COPEL. Philip. J. Sc. 81 (1952) 16; Fern Fl. Philip. 2 (1960) 223.

*Stipe* to c. 15 cm, copiously short-spiny (spines c. 2 mm); scales 15–20 by 1 mm, dark with pale fragile edges. Lower *pinnæ* gradually reduced, lowest commonly less than 10 cm long; largest pinna 40 cm long or more. *Pinnules* to 100 by 24 mm, sessile, acuminate, lowest segment more or

less free, rest of pinnule lobed nearly to costa; costules 4–4½ mm apart; veins to 12 pairs; lamina-segments firm, crenate, lowest ones sometimes deeply so. *Sori* near costules; indusium thin and pale except near receptacle, almost covering sorus to maturity but not closed on side remote from costule, at maturity breaking and the thinner parts sometimes caducous, remnant then reflexed against costule; paraphyses not longer than sporangia. *Scales and hairs*: pinna-rachis glabrescent, rather pale, bearing scattered small slender spines or warts (lower pinnæ most spiny); costal scales sparse, dull brown, rather broad, sometimes with a dark seta near apex; costular scales few, ovate, flat, pale, not bullate but sometimes convex; on lower surface of veins many very short appressed but conspicuous hairs.

Type specimen: LOHER, Mt Maquiling, Luzon, April 1906 (not seen at P; dupl. at M).

Distr. *Malaysia*: Philippines (Luzon).

Ecol. In mid-mountain forest; few records of altitude in Luzon.

Note. This species is very near *C. spinulosa* WALL. which is widely distributed from the NE. Himalayas to S. China and Formosa (syn. *C. austrosinica* CHRIST and *C. taiwaniana* NAKAI), but appears to differ in short less spiny stipe and in gradually reduced lower pinnæ.

**80. *Cyathea dicksonioides*** HOLTUM, Blumea 11 (1962) 529.—Fig. 10c, d, 17.

*Trunk* to 3 m, 20 cm ø, bearing fronds in 2 whorls of 10–12 each; fronds to 90 cm long, those of outer whorl almost straight, those of inner whorl bent downwards near the base. *Stipe* to 10 cm, not spiny, covered with scales; scales 45 mm by 2 mm wide at base, shining, castaneous with narrow paler fragile edges, straight, the finely acuminate apical part much twisted; sparse small scales beneath the larger ones. Lowest *pinnæ* rather abruptly reduced, 8–10 cm long, longest pinnæ 17–20 cm. *Pinnules* close, largest 35 mm long, sessile, 5 mm wide above the widened base, pinnate almost throughout; midribs of tertiary leaflets 2 mm apart. *Tertiary leaflets* contiguous, almost triangular with rounded tip, edges strongly reflexed, basal leaflets to almost 4 mm long and distinctly lobed; veins to 4 pairs, lower 1–2 pairs forked, not raised on upper surface, pale and strongly raised on lower surface. *Sori* 2–4 on each leaflet; indusium pale, firm, attached on costular side and forming a hood which partly covers the mature sorus, in shape very much like the inner indusium of *Dicksonia*; receptacle swollen; sporangia many; no paraphyses seen. *Scales and hairs*: all rachises and costae minutely warty and glabrescent on lower surface, antrorse hairs on upper surface pale; residual scales on rachises long, pale brown, very narrow, entire; on lower surface of midribs of tertiary leaflets a few spreading light-brown hair-tipped scales.

Type specimen: HOOGLAND & SCHODDE 7171, Western Highlands, NE. New Guinea (L).

Distr. *Malaysia*: NE. New Guinea (2 collections).



Fig. 17. *Cyathea dicksonioides* HOLTUM (small plant in centre) with taller *C. atrox* C. CHR., in tree-fern grassland, N. slopes of Sugarloaf complex, Western Highlands, Territory of New Guinea, 2880 m (R. D. HOOGLAND).

Ecol. In tree-fern grassland, infrequent, 2600–2900 m.

Note. In form of leaflets and in basal scales this is very like *C. macgregorii*, but it is quite different in indusium and costular scales, and in habit of growth, the fronds being in two whorls, those of the inner whorl bent downwards at the base.

**81. *Cyathea heterochlamydea*** COPEL. in Elmer, Leaflet. Philip. Bot. 2 (1908) 418; Fern Fl. Philip. 2 (1960) 218.—*Hemitelia heterochlamydea* v. A. v. R. Handb. Suppl. (1917) 53.—*Hemitelia caudiculata* ROSENST., Med. Rijksherb. 31 (1917) 2.—*C. caudiculata* DOMIN, Acta Bot. Bohem. 9 (1930) 104.—*C. merrillii* COPEL. Philip. J. Sc. 46 (1931) 212; Fern Fl. Philip. 2 (1960) 231.—**Fig. 9c.**

*Stipe* short, warty or short-spiny; pneumathodes in 2–3 irregular rows; scales dark, shining, with narrow (often abraded) paler fragile edges. Lower *pinnae* gradually reduced; longest to 60 cm long. *Pinnules* commonly to 100 by 18 mm, exceptionally to 120 by 23 mm, sessile, strongly acuminate, lowest segment often free, on largest pinnules 2–3 pairs segments constricted on acroscopic base, decurrent basiscopically, most pinnules lobed almost to costa throughout with narrow sinuses between segments; costules  $3\frac{1}{2}$ –4 mm apart; veins commonly 10–11 pairs, on largest pinnules to 14 pairs; lamina-segments firm, crenate, basal free ones sometimes deeply so. *Sori* near costules; indusium firm, brown, overarching costular side of sorus at maturity, its edge firm, open on side remote from costule; receptacle rather tall, slightly swollen; paraphyses short. *Scales and hairs*: lower surface of pinna-rachis finely warty, glabrescent or bearing very small irregular short-fringed pale brown scales and sometimes sparse crisped hairs; lower surface of costae usually with numerous very small irregular short-fringed scales and sometimes also short crisped hairs, larger scales usually all deciduous, residual ones flat, dull brown, with setiform apex and sometimes 1–2 other setae; costules of fertile segments usually without scales, on sterile ones a few ovate thin convex or just bullate scales.

Type specimen: ELMER 9742, Cuernos Mts, Negros (MICH; dupl. at US, FI, BO, K, P, A, SYD, U, L, BM).

Distr. *Malaysia*: Philippines (Luzon, Negros, Panay, Mindanao).

Ecol. Little information; apparently in mid-mountain forest.

Note. Apart from size of indusium and larger pinnules, there seems little distinction between this and *C. caudata* (J. SM.) COPEL.

**82. *Cyathea edanoi*** COPEL. Philip. J. Sc. 46 (1931) 211; Fern Fl. Philip. 2 (1960) 219.

*Stipe* c. 5 cm; scales dark, rather narrow with narrow fragile edges. Lower *pinnae* gradually reduced and close together, lowest 5 cm long; longest *pinnae* 40 cm. *Pinnules* to 60 by 14 mm, almost sessile, shortly caudate-acuminate, lowest 2 segments almost free, most of remaining segments constricted at base on acroscopic side, de-

current basiscopically; costules 3– $3\frac{1}{2}$  mm apart; veins 8 pairs; lamina-segments rather thin, edges crenate. *Sori* near costules; indusium large, hemitelioid, covering at least half sorus on costular side at maturity, rather firm and dark. *Scales and hairs*: lower surface of pinna-rachis glabrescent; lower surface of costae bearing few flat light-brown scales, sometimes with a long seta; on costule no scales seen (all fertile).

Type specimen: EDAÑO BS 78709, summit of Mt Cagua, Luzon (MICH; dupl. at BO).

Distr. *Malaysia*: Philippines (Luzon, 3 collections).

Ecol. At 1300 m.

Note. This is very closely related to *C. heterochlamydea*, having similar sori and scales, and may perhaps be a small form of that species due to habitat conditions at or near a mountain-summit.

**83. *Cyathea fuliginosa*** (CHRIST) COPEL. Philip. J. Sc. 4 (1909) Bot. 43; Fern Fl. Philip. 2 (1960) 224.—*Alsophila fuliginosa* CHRIST, Bull. Herb. Boiss. 6 (1898) 138; v. A. v. R. Handb. (1908) 39.—*Alsophila mindanensis* CHRIST in Warb. Monsunia (1900) 90, p.p. (fertile specimen; sterile is *Dicksonia*); v. A. v. R. Handb. (1908) 44.—*C. loheri* var. *tonglonensis* CHRIST, Philip. J. Sc. 2 (1907) Bot. 180; v. A. v. R. Handb. (1908) 787.—*C. lanaensis* CHRIST, Philip. J. Sc. 3 (1908) Bot. 271; v. A. v. R. Handb. Suppl. (1917) 23; COPEL. Fern Fl. Philip. 2 (1960) 219.—*C. mindanensis* COPEL. Philip. J. Sc. 4 (1909) Bot. 34; Fern Fl. Philip. 2 (1960) 223.—*C. bicolor* COPEL. in Elmer, Leaflet. Philip. Bot. 3 (1910) 804; Fern Fl. Philip. 2 (1960) 225.—*Hemitelia tonglonensis* v. A. v. R. Bull. Jard. Bot. Btzg II, n. 7 (1912) 14; Handb. Suppl. (1917) 42.—*C. warihon* COPEL. in Elmer, Leaflet. Philip. Bot. 5 (1913) 1680; Fern Fl. Philip. 2 (1960) 226.—*Alsophila warihon* C. CHR. Ind. Fil. Suppl. 2 (1917) 4.—*Hemitelia bicolor* v. A. v. R. Handb. Suppl. (1917) 44.—*Hemitelia warihon* v. A. v. R. l.c. 43.—*C. tonglonensis* DOMIN, Pterid. (1930) 264.—*C. squamicosta* COPEL. Philip. J. Sc. 46 (1931) 212; Fern Fl. Philip. 2 (1960) 209.—*C. dura* COPEL. Philip. J. Sc. 81 (1952) 13; Fern Fl. Philip. 2 (1960) 206.—*C. lepidigera* COPEL. Philip. J. Sc. 81 (1952) 16; Fern Fl. Philip. 2 (1960) 224.—*C. sulitii* COPEL. Philip. J. Sc. 81 (1952) 18; Fern Fl. Philip. 2 (1960) 225.—*C. biliranensis* COPEL. Philip. J. Sc. 84 (1955) 162.

*Trunk* to at least 5 m. *Stipe* c. 7 cm, closely warty or with conical spines under 1 mm long; scales to 15 by  $1\frac{1}{2}$  mm, dark, shining, with fragile concolorous edges. Lower *pinnae* gradually reduced, lowest c. 7 cm long; longest *pinna* 40–50 cm (exceptionally to 90 by 21 mm), sessile, short-acuminate, basal basiscopical segment longest, basal 1–2 segments free, rest of pinnule lobed nearly to costa; costules 3–4 mm apart; veins 8–9 pairs; lamina-segments very firm, crenate, fertile ones more deeply so than sterile, on largest pinnules the basal segments sometimes deeply lobed, several pairs being separately adnate to costa. *Sori* near costules; indusium hemitelioid,



firm, dark, with thinner uneven edge at maturity, on type specimen about a quadrant of a circle, on some others more nearly a semicircle; paraphyses not longer than sporangia, some near apex of receptacle flat at base. *Scales and hairs*: upper surface of main rachis and pinna-rachis bearing spreading very narrow crisped scales to 7 mm long in addition to usual antrorse hairs; lower surface of main rachis closely warty, glabrescent; lower surface of pinna-rachis closely warty, pale, bearing more or less deciduous pale bullate-based scales, these more abundant distally; costae at first copiously scaly, scales near base acuminate, slightly bullate at base, grading to small bullate scales distally, all scales light brown and entire; old costae conspicuously warty beneath; costules glabrescent or bearing bullate scales.

Type specimen: LOHER 893, March 1897, Baguio, Luzon (P; dupl. at K, US).

Distr. *Malaysia*: Philippines (Luzon, Mindanao, Biliran).

Ecol. In forest at 640–2400 m.

Notes. LOHER's *n.* 893 was not cited with the original description by CHRIST, but appears on the original label of the specimens at Paris, Kew and Washington. The degree of scabiness of lower surfaces of pinna-rachis and costae varies considerably, and also the abundance of warts; warts and scales are more abundant on the lower pinnae, and possibly also on plants in more exposed conditions of habitat.

**84. *Cyathea semiamplectens* HOLTUM, Kew Bull. 16 (1962) 62.**

*Trunk* 150–200 cm tall, stout, bearing numerous fronds to 175 cm long. *Stipe* 5–15 cm, not spiny, covered with scales; scales 20–30 by 1–3 mm, narrower ones often with dark median band, wider ones mostly entirely pale except the apex, setae on the fragile edges rare. Lower *pinnae* gradually reduced, lowest 4–12 cm long, longest 40 cm. Largest *pinnules* 50–75 by 15–20 mm, sessile, hardly acuminate, with 6–10 pairs of separately adnate segments; costules 3–4½ mm apart; veins to 7 pairs, not prominent on either surface; lamina-segments firm, sterile ones crenate, larger fertile ones lobed ½–¾ to costule. *Sori* near costules; indusium hemitelioid, nearly 1 mm wide, covering costular side of ripe sorus; no paraphyses seen. *Scales and hairs*: pinna-rachis rather persistently covered beneath with very small light brown bullate scales, sometimes with setiform apex, and very narrow entire scales; scales on costae small, pale brown, bullate, entire, with some broader flat elongate ones; costular scales mostly deciduous.

Type specimen: WOMERSLEY 11500, Eastern Highlands, NE. New Guinea (BRI; dupl. at L).

Distr. *Malaysia*: E. New Guinea (two collections).

Ecol. At 3300–3560 m, 'in broken subalpine shrubbery' (WOMERSLEY), exposed to sun; and 'in subalpine forest' (BRASS). The latter collection has larger fronds, with pinnules more dissected.

**85. *Cyathea alleniae* HOLTUM, Kew Bull. 16 (1962) 52.**

*Trunk* to 4 m. 15 cm ø; several smaller crowns of fronds sometimes produced by branches from the trunk. *Stipe* at least 30 cm, near base with many thick conical spines to 2 mm long; scales dark, shining, to 20 by 1½ mm, fragile edges mostly abraded; pneumathodes to 25 mm long, in a single row. *Pinnae* to 70 cm long. *Pinnules* sessile, rather easily detached when dry, short-acuminate, largest 140–150 by 30 mm, more than half the segments separated by wide sinuses and constricted at base, connected by a narrow costal wing, only the lowest segments sometimes quite free; costules 5–6 mm apart; veins to 12 pairs; lamina-segments deeply crenate, the larger ones lobed halfway to costule, veins in such lobes pinnate. *Sori* near costules; indusium a firm brown scale of rather irregular shape on costular side, often nearly circular, sometimes unevenly lobed, rarely extending round base of receptacle on side remote from costule; paraphyses shorter than sporangia, some near apex of receptacle broad and scale-like at base. *Scales and hairs*: pinna-rachis near base glabrescent and warty, distal half at least bearing crisped hairs on lower surface; costae bearing some hairs as pinna-rachis on lower surface, also firm brown elongate scales, the larger ones with a dark setiform apex and sometimes dark marginal setae; scales on costules bullate, brown. *Fronds of branch-crowns*: pinnae to 18 cm long, pinnules to 65 by 13 mm, lowest 1–2 pairs of segments deeply lobed, lowest 4–6 pairs of segments constricted at base on acroscopic side; veins to 9 pairs; sori and scales as fronds of main crown.

Type specimen: B. E. G. MOLESWORTH-ALLEN 4127, Kuala Terla, Pahang (K; dupl. at US).

Distr. *Malaysia*: Malay Peninsula.

Ecol. On forest edge, steep ground, at 1200 m.

**86. *Cyathea costulifera* DOMIN, Acta Bot. Bohem. 9 (1930) 108.—*Hemitelia montana* v. A. v. R. Bull. Jard. Bot. Btzg III, 2 (1920) 153, non *C. montana* Sm. 1793.**

*Stipe* 70 cm, warty almost throughout; many persistent scales to 20 by 1½ mm, on lower 30 cm; main rachis glabrescent, pale, smooth or moderately warty. *Pinnae* to 50 cm long. *Pinnules* to 60 by 16 mm, sessile, abruptly pointed, lobed almost to costa, no free segments; costules 3 mm apart; veins 7–8 pairs; lamina-segments thin, subentire, sinuses ½ mm wide. *Sori* near costules; indusium firm, brown, large, backing the costule, more than a semicircle; receptacle swollen; paraphyses not evident on old sori. *Scales and hairs*: lower surface of pinna-rachis distally bearing a thin covering of pale crisped hairs and some very small scales; scales near base of costae narrow, flat, dark, with some dark setae near apices, also very small scales; many small pale bullate scales on costules.

Type specimen: BÜNNEMEIJER 4606, Mt Merapi, Sumatra (BO; dupl. at L).

Distr. *Malaysia*: Sumatra (one collection).

**87. *Cyathea caudata*** (J. SM.) COPEL. Philip. J. Sc. 1, Suppl. II (1906) 144; Fern Fl. Philip. 2 (1960) 222.—*Alsophila caudata* J. SM. ex HOOK. [J. Bot. 3 (1841) 419, *nomen*] Sp. Fil. 1 (1844) 52, t. 20B; Syn. Fil. (1866) 42; v. A. v. R. Handb. (1908) 37, 785.—*Hemitelia manilensis* PR. Abh. K. Böhm. Ges. Wiss. V, 5 (1848) 351; v. A. v. R. Handb. Supplement (1917) 53.—*Amphicosmia manilensis* MOORE, Ind. Fil. (1857) 61.—*Hemitelia caudata* METT. Fil. Lechl. 2 (1859) 30; v. A. v. R. Handb. Suppl. (1917) 52.—*C. manilensis* DOMIN, Pterid. (1929) 264.—*C. dupaxensis* COPEL. Philip. J. Sc. 46 (1931) 211; Fern Fl. Philip. 2 (1960) 217.—*C. brevipes* COPEL. Philip. J. Sc. 81 (1952) 18; Fern Fl. Philip. 2 (1960) 232.—*C. arborescens* COPEL. Philip. J. Sc. 84 (1955) 162.

Stipe short, copiously warty; scales narrow, dark, shining, to 15 mm long. Lower pinnae gradually reduced, lowest 5–8 cm long; longest pinnae 40–50 cm. Pinnules commonly to 85 by 16–18 mm, almost sessile, more or less caudate-acuminate (cauda on type 25 mm); costules 3–3½ mm apart; veins to 10 pairs; lamina-segments firm, rather strongly crenate-serrate. Sori near costules; indusium hemitelioid, in shape a quadrant of a circle to a semicircle, firm, reflexed against costule; receptacle swollen; paraphyses short, some apical ones broad at base. Scales and hairs: lower surface of pinna-rachis glabrescent, sometimes bearing crisped hairs towards apex; lower surface of costae bearing sparse flat brown thin-edged scales, some with a few marginal setae, also very small scales and sometimes a few crisped hairs; scales on costules flat or somewhat convex, not bullate.

Type specimen: CUMING 267, Luzon (K; dupl. at P, L, A).

Distr. *Malaysia*: Philippines (Luzon, Mindoro).

Ecol. In mid-mountain forest; few records of altitude.

Note. Apart from size of indusium and of pinnules, there seems no clear distinction between this species and *C. heterochlamydea* COPEL.

**88. *Cyathea borneensis*** COPEL. Philip. J. Sc. 6 (1911) Bot. 135; v. A. v. R. Handb. Suppl. (1917) 33.—*Alsophila latebrosa* var. *denudata* BEDD. J. Bot. 31 (1893) 225; RIDL. J. Mal. Br. R. As. Soc. 4 (1926) 9.—*C. hemichlamydea* COPEL. Philip. J. Sc. 6 (1911) Bot. 361.—*Hemitelia hemichlamydea* v. A. v. R. Handb. Suppl. (1917) 47, 488.—*C. obtusata* ROSENST. Med. Rijks herb. n. 31 (1917) 1; HOLTTUM, Gard. Bull. S. S. 8 (1935) 306, pl. 30; Rev. Fl. Mal. 2 (1954) 121.

Trunk to 2 m or more. Stipe 5–25 cm, short-spiny or warty; scales to 15 by 1 mm, dark, shining, fragile edges narrow and often abraded; pneumathodes 12–18 mm long, in a single row, with gaps between them. Lower pinnae rather irregularly reduced and variable in size, lowest 4–10 cm long, longest where stipe is longest; longest pinnae 60 cm. Largest pinnules 80–100 by 17–22 mm, almost sessile, acuminate, lobed almost to costa, basal segment not free; costules 3½–5 mm apart; veins to 10 pairs; lamina-segments thin but firm, almost entire, ends rounded, sinuses narrow. Sori

near costules; indusium rather thin, on costular side, variable in shape and size, reaching the costule and usually visible at maturity of sorus; receptacle swollen; paraphyses short. Scales and hairs: pinna-rachis pale to purplish, bearing some crisped hairs distally and sometimes throughout, also some residual very narrow dark spreading flexuous entire scales; scales on costae dark, entire, acuminate, flat or bullate-based, grading to bullate scales distally; rather dark bullate scales on costules.

Type specimen: C. J. BROOKS 58, Mt Penrissen, Sarawak (MICH; dupl. at BM).

Distr. S. Siam northwards to Mergui, in *Malaysia*: Malay Peninsula, Borneo.

Ecol. In forest, from lowland to 1100 m.

Notes. Bornean specimens seem on the whole larger than those from Malaya, and are also more often suffused with purple on the rachis which in Malayan specimens is usually green (pale when dry). ROSENSTOCK wrongly cited the number of the type collection of his *C. obtusata* as 1148; it should be 7148 (*leg.* KING's Coll., Perak).

**89. *Cyathea fenicis*** COPEL. Philip. J. Sc. 3 (1909) Bot. 354; *ibid.* 4 (1909) 61; Fern Fl. Philip. 2 (1960) 232.—*Alsophila fenicis* C. CHR. Ind. Fil. Suppl. (1913) 5; v. A. v. R. Handb. Suppl. (1917) 66.—*Alsophila fujiana* NAKAI, Bot. Mag. Tokyo 41 (1927) 72.

Stipe 60 cm; spines 1 mm long; scales 15 mm long, narrow, dark; one pair of pinnae 6 cm long near base of stipe (*vide* COPELAND). Largest pinnae 40 cm long. Largest pinnules 80–100 by 13–21 mm, sessile, acuminate, lowest 1–2 pairs of segments constricted at base and nearly free, rest of pinnule lobed nearly to costa; costules 3½–4½ mm apart; veins 10–11 pairs; lamina-segments firm, crenate. Sori near costules; indusium small, brown, on costular side. Scales and hairs: pinna-rachis beneath glabrescent; costal scales few, flat, rather broad, entire, paler distally; on costules pale entire scales, ovate, grading to bullate.

Type specimen: FENIX BS 3797, Batan Islands (US; dupl. at P).

Distr. Taito I. (near Formosa), in *Malaysia*: Philippines (N. Luzon: Batan Is., several collections).

Notes. The type was presumably in the Manila herbarium, destroyed during the war. Specimens of the same collection at US and P do not show the stipe; all other details given above are taken from them. COPELAND wrongly reported this species as exindusiate.

**90. *Cyathea junghuhniana*** (KUNZE) COPEL. Philip. J. Sc. 4 (1909) Bot. 58.—*Alsophila extensa* [non (FORST.) SPR.] BL. En. Pl. Jav. (1828) 246 (*p.p.?*).—*Alsophila lunulata* [non (FORST.) R. BR.] BL. l.c. (*p.p.?*).—*Alsophila junghuhniana* KUNZE, Bot. Zeit. 6 (1848) 284.—*Hemitelia javanica* PRESL, Epim. Bot. (1851) 34.—*Alsophila robusta* DE VRIESE in Jungh. Java 1 (1852) 310, 476.—*Alsophila debilis* DE VRIESE, l.c.—*Alsophila melanopus* HASSK. in Hook. J. Bot. Kew Misc. 7 (1855) 325;



Obs. Bot. Fil. 1 (1856) 42; v. A. v. R. Handb. (1908) 40; Suppl. (1917) 65(?).—*Amphicosmia javanica* MOORE, Ind. Fil. (1857) 60.—*Hemitelia junghuhniana* METT. Fl. Lechl. 2 (1859) 31; Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 55; RACIB. Fl. Btztg 1 (1898) 38, *p.p.*, excl. *var. dissoluta*; v. A. v. R. Handb. (1908) 28; Suppl. (1917) 45, Corr. 44; BACKER & POSTH. Varenfl. Java (1939) 28.—*Hemitelia latebrosa* (WALL.) METT. Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 54, *p.p.* (*pl. jav. tantum*); RACIB. Fl. Btztg 1 (1898) 39; v. A. v. R. Handb. (1908) 38, *p.p.*; BACKER & POSTH. Varenfl. Java (1939) 27.—*C. melanopus* COPEL. Philip J. Sc. 4 (1909) Bot. 48.—*Hemitelia glaucophylla* v. A. v. R. Bull. Jard. Bot. Btztg II n. 7 (1912) 16; Handb. Suppl. (1917) 50.—*Hemitelia alsophiliformis* v. A. v. R. Bull. Jard. Bot. Btztg II, n. 16 (1914) 15; Handb. Suppl. (1917) 46.—*Hemitelia merapiensis* v. A. v. R. Bull. Jard. Bot. Btztg II, n. 16 (1914) 16; Handb. Suppl. (1917) 45.—*Hemitelia fallax* v. A. v. R. Bull. Jard. Bot. Btztg III, 2 (1920) 153, incl. *var. major*.—*C. glaucophylla* DOMIN, Pterid. (1929) 264.—*C. alsophiliformis* DOMIN, l.c. 263.—*C. merapiensis* DOMIN, l.c. 264.—*C. fallax* DOMIN, Acta Bot. Bohem. 9 (1930) 115.

*Trunk* to 2 m or more; leaf-bases persistent. *Stipe* 30–50 cm or more, base bearing spines  $1\frac{1}{2}$ – $2\frac{1}{2}$  mm long; scales to 30 by 2 mm, dark, shining; pneumathodes 5–14 mm long, in a close double or triple row. Lower *pinnae* somewhat reduced; longest *pinnae* 55–70 cm long. Largest *pinnules* 80–115 by 14–21 mm, sessile, acuminate, lobed almost to costa, lowest segment not free; costules  $3\frac{1}{2}$ – $4\frac{1}{2}$  mm apart; veins 10–12 pairs; lamina-segments firm, subentire to distinctly crenate (the latter usually when fertile). *Sori* near costules; indusium hemitelioid, variable in size and shape, rather thin, when largest semicircular in shape and distinctly visible on costular side of mature sorus; receptacle swollen; paraphyses short, slender. *Scales and hairs*: pinna-rachis smooth, glabrescent, sometimes with minute fringed scales; scales on costae elongate, flat, entire, of varying size; on costules bullate, or acuminate with bullate base.

Type specimen: JUNGHUHN, Java (Herb. SCHLECHTENDAL, not seen; dupl. at L, K).

Distr. *Malaysia*: South and Central Sumatra, Java.

Ecol. In forest at 1000–2000 m, very abundant above Tjibodas on Mt Gedeh in West Java.

Note. All authors from METTENIUS to BACKER & POSTHUMUS tried to distinguish both *C. latebrosa* (WALL.) COPEL. and *C. junghuhniana* in West Java, but the former does not occur there. For confusion of *C. junghuhniana* with *C. raciborskii*, see note under latter species.

91. *Cyathea raciborskii* COPEL. Philip. J. Sc. 4 (1909) Bot. 45.—*Hemitelia capensis* [non (L. f.) R. BR.] HOOK. Sp. Fil. 1 (1844) 36, *p.p.*; Syn. Fil. (1865) 29, *p.p.*—*Hemitelia crenulata* METT. Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 55; RACIB. Fl. Btztg 1 (1898) 38; v. A. v. R. Handb. (1908) 27; Suppl. (1917) 42; BACKER & POSTH. Varenfl. Java (1939) 27, non *C. crenulata* BL. 1828.—*Alsophila*

*crenulata* HOOK. Syn. Fil. (1866) 44.—*Hemitelia junghuhniana* var. *dissoluta* RACIB. Fl. Btztg (1898) 38.—*Alsophila brevifoliolata* v. A. v. R. Bull. Jard. Bot. Btztg II, n. 20 (1915) 3; Handb. Suppl. (1917) 64.—*C. brevifoliolata* v. A. v. R. Bull. Jard. Bot. Btztg II, n. 28 (1918) 13.

*Trunk* rarely to 2 m. *Stipe* 30–50 cm, warty near base; scales little over 10 mm by 1 mm, dark, shining; pneumathodes in a single row (in two rows on largest fronds), 2–5 mm long. Lowest *pinnae* varying in size, smallest seen 22 cm long; largest *pinnae* 40–50 cm. Largest *pinnules* 65 by 14(–20) mm, sessile, abruptly narrowed at apex or short-acuminate, lobed almost to costa, lowest segment not free; costules  $3\frac{1}{2}$  mm (rarely to  $4\frac{1}{2}$  mm) apart; veins to 8 pairs; lamina-segments rather thin, usually almost entire, lobed in very wide pinnules. *Sori* near costules, usually only on lowest 2–3 pairs of veins; indusium on costular side of sorus, of variable size (in Sumatran specimens sometimes encircling base of receptacle); paraphyses not longer than sporangia, some several cells wide at base. *Scales and hairs*: lower surface of pinna-rachis bearing many persistent very small fringed scales and sometimes sparse crisped hairs on distal part; on costae and costules many small pale bullate scales throughout, with some darker elongate scales near base of costae.

Type specimen: BLUME, Mt Boerangrang, W. Java (L; dupl. at BO).

Distr. *Malaysia*: S. Sumatra, W. Java.

Ecol. In forest at 1200–1600 m, abundant above Tjibodas on Mt Gedeh.

Note. This species was confused with *C. junghuhniana* by v. A. v. R. and others, as indicated by their determination of specimens in herbaria. The two species grow side by side in the forest above Tjibodas, and in my experience are quite distinct in size, shape of pinnules, scales on costae, and in pneumathodes of stipe.

92. *Cyathea glaberrima* HOLTUM, Kew Bull. 16 (1962) 55.

*Trunk* slender, to 2 m, bearing many fronds to 190 cm long. *Stipe* c. 8 cm, finely warty; scales many, light castaneous, shining, to 15 by  $1\frac{1}{2}$  mm, fragile edges narrow, not setiferous. Lower *pinnae* gradually reduced, lowest 3–4 cm long; longest pinna 50 cm. *Pinnules* distinctly dimorphous; sterile pinnules to 150 by 25 mm, lowest on stalks to 8 mm long, apex long-acuminate, lobed to 3–4 mm from costa, costules 6– $6\frac{1}{2}$  mm apart, veins 9 pairs, lowest from costa; fertile pinnules to 120 by 18 mm, on stalks to 6 mm long, lobed as sterile, costules 5– $5\frac{1}{2}$  mm apart. Lower *sori* medial, distal ones nearer to costule; indusium a small dark brown scale on costular side; receptacle large; paraphyses shorter than sporangia. *Scales and hairs*: pinna-rachis smooth, pale, glabrous except at bases of costae; at bases of costae on lower surface and adjacent parts of rachis a few rather thick crisped hairs and bullate scales; on costules very few bullate scales.

Type specimen: BRASS 27092, Fergusson I. (K; dupl. at US).

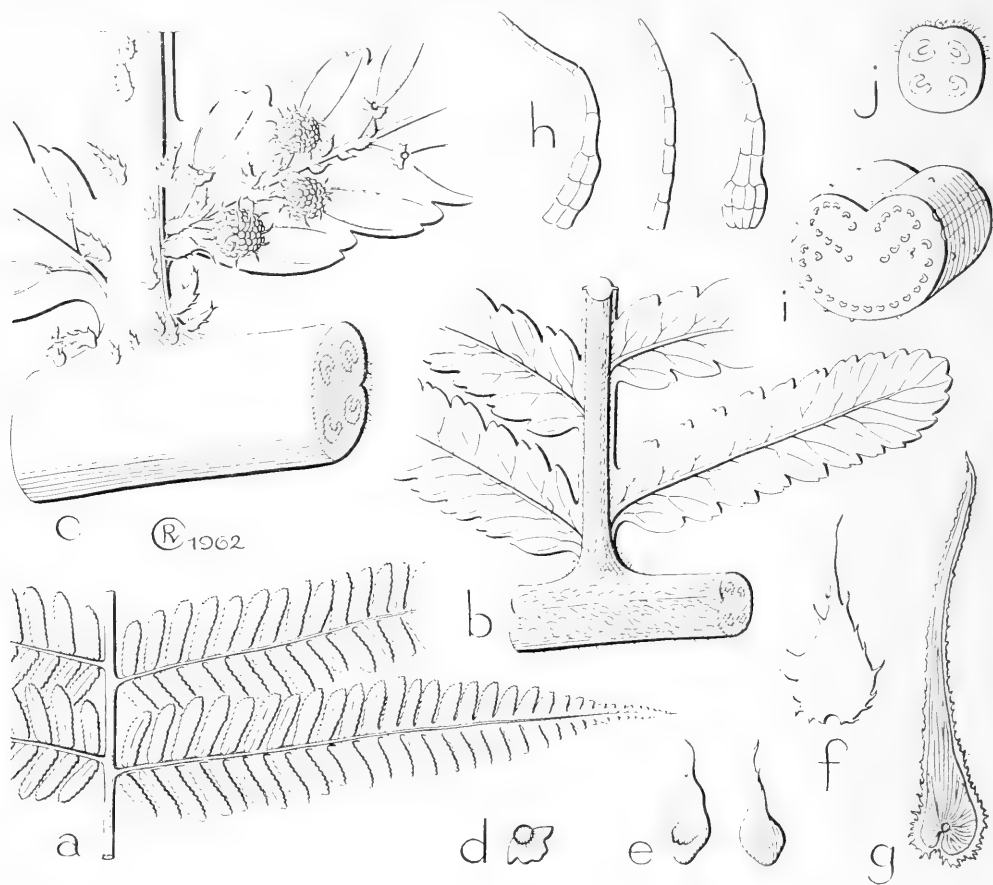


Fig. 18. *Cyathea incisoserrata* COPEL. a. Pinnules attached to pinna-rachis, upper surface,  $\times \frac{2}{3}$ , b. pinna-rachis and base of pinnule, upper surface,  $\times 4$ , c. as b, lower surface, showing sori and scales,  $\times 10$ , d. indusium and base of receptacle,  $\times 20$ , e. scales from costule,  $\times 20$ , f. scale from pinna-rachis,  $\times 20$ , g. scale from stipe,  $\times 6$ , h. paraphyses,  $\times 50$ , i. section of stipe,  $\times \frac{1}{3}$ , j. section of pinna-rachis,  $\times 6$ , (cult. R. B. G. Kew, origin Malay Peninsula).

Distr. *Malaysia*: D'Entrecasteaux Islands: Ferguson and Goodenough Is.

Ecol. In mossy oak forest, at 900–1400 m.

Note. The shallowly lobed pinnules are unusual in this group of species; the position of the basicopic vein, springing from the costa, is associated with this condition, as in *sect. Schizocaena*.

93. *Cyathea punctulata* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 28 (1918) 13.—*Alsophila punctulata* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 20 (1915) 5; Handb. Suppl. (1917) 64.

Stipe dark, warty, 40 cm or more, near base persistently scaly; scales to 40 by 2–3 mm, castaneous, shining, with narrow fragile edges. *Pinnae* to 70 cm long. Largest pinnules 125 by 22 mm, caudate-acuminate, lowest 6 pairs on larger pinnae distinctly stalked (stalk of lowest 3–5 mm), rest sessile, lobed nearly to costa; costules  $4\frac{1}{2}$  mm

apart; veins to 12 pairs; lamina-segments very firm, rather strongly crenate-serrate, lowest one on larger pinnules reduced and almost free, sinuses narrow. *Sori* at  $\frac{1}{3}$  distance from costule to edge; indusium very small, usually entirely on costular side, dark near its attachment to base of receptacle, outer edge pale, uneven; receptacle tall, sporangia very numerous; paraphyses short, slender. *Scales and hairs*: pinna-rachis closely and finely warty on lower surface, rather pale, glabrescent, residual scales small, pale, short-fringed; scales near base of costae broad, thin, ovate-acute, flat, entire or with short pale hairs, grading distally to bullate scales, very small irregular short-fringed scales also abundant; most scales on costules bullate, pale brown.

Type specimen: MATTHEW 679, Mt Korinchi, Sumatra (BO; dupl. at K).

Distr. *Malaysia*: Sumatra (one collection).

Ecol. In forest, at 2400 m.

94. *Cyathea incisoserrata* COPEL. Philip. J. Sc. 6 (1911) Bot. 361; HOLTUM, Gard. Bull. S. S. 8 (1935) 305.—*Alsophila ornata* var. *sikkimensis* (non CL. & BAK.) BEDD. J. Bot. 31 (1893) 225.—*Alsophila ornata* (non SCOTT) BEDD. Kew Bull. (1909) 423.—*Alsophila incisoserrata* C. CHR. Ind. Fil. Suppl. (1913) 5; v. A. v. R. Handb. Suppl. (1917) 72.—*Alsophila latebrosa* var. *ornata* RIDL. J. Mal. Br. R. As. Soc. 4 (1926) 8.—Fig. 7, 8b, 18.

Trunk to 4 m, 12 cm  $\phi$  including leaf-bases. Stipe to 85 cm, warty or with conical spines to 1½ mm long on abaxial surface, rather persistently but sparsely scaly almost throughout, scales hardly more than 10 by 1 mm; pneumathodes in a continuous double row, almost coalescent. Lower pinnae slightly reduced, longest 70 cm. Pinnules commonly to 100 by 25 mm, largest sometimes 120 by 35 mm, sessile, acuminate, several pairs of segments near base distinctly separate, connected by a narrow costal wing; costules 4½–5½ mm apart; veins commonly 12 pairs, 14–15 pairs in largest segments, middle ones in largest segments pinnately branched; lamina-segments rather thin, strongly crenate, lower ones of largest pinnules often deeply lobed, almost all separated by wide sinuses except on smaller pinnae. Sori near costules; indusium hemitelioid, very small, often bilobed, hidden by sporangia; receptacle not swollen; paraphyses longer than sporangia, some of them 2–3 cells wide at base. Scales and hairs: lower surface of pinna-rachis almost smooth, rather pale (green when living), glabrescent or with some very small fringed scales; scales near base of costae elongate, flat, entire, or with short marginal hairs, brown, grading to bullate scales; bullate scales abundant on costules.

Type specimen: C. J. BROOKS 105, Mt Singie, Sarawak (MICH; dupl. at BM).

Distr. *Malaysia*: Sarawak, Malay Peninsula.

Ecol. In forest or on edge of forest, from the lowland to 1250 m.

Note. This is very near *C. latebrosa*, agreeing in sori and scales on pinnules, but the size and shape of pinnules is characteristic. Young plants grown from spores at Kew agree exactly with the parent plant in these characters. The scales persistent throughout the stipe also show a difference from those of *C. latebrosa*.

95. *Cyathea physolepidota* ALSTON, Nova Guinea n.s. 7 (1956) 1.

Stipe 25 cm, strongly spiny, spines 3–5 mm long; scales sparse, to 10 by 1¼ mm, brown with pale fragile edges which have many slender hairs irregularly directed (not all deflexed as originally described). Main rachis smooth and rather pale, glabrescent. Lower pinnae reduced (lowest not seen); longest pinna 22 cm long. Largest pinnules 32 by 9 mm, sessile, short-acuminate, lobed to within 1 mm of costa, lowest segment not free; costules 2½ mm apart; veins 6 pairs, usually simple; lamina-segments firm, edges slightly sinuous or crenulate. Sori near costules; indusium very small, hemitelioid, usually bilobed; receptacle slender, rather tall; paraphyses short. Scales and hairs:

lower surface of pinna-rachis and costae bearing more or less abundant pale brown bullate scales, on bases of costae also sometimes flat scales with setiform apex.

Type specimen: CARR 13871, above the Gap, Papua (BM; dupl. at L, SING).

Distr. *Malaysia*: E. New Guinea (2 collections).

Ecol. In forest, 2200–2500 m.

96. *Cyathea kanehirae* HOLTUM, nom. nov.—*Alsophila arfakensis* GEPP in Gibbs, Arfak (1917) 70 (non *C. arfakensis* GEPP, l.c.).

Stipe not known; rachis smooth and glabrescent on lower surface. Pinnae to 50 cm long; pinnules widely spaced and jointed to rachis. Pinnules to 80 by 20 mm, lower ones on stalks 6–7 mm long; basal 1–2 pairs of segments quite free and articulate to costa, next 2–3 pairs constricted at base, rest of pinnule lobed nearly to costa; costules 6 mm apart; veins 7–8 pairs, mostly forked, lowest often with each branch again forked, not prominent on either surface; lamina-segments thick and rigid, edges slightly crenate, apices rounded. Sori near costules (except lowest); indusium very small, hemitelioid, sometimes bilobed. Scales and hairs: scales on costae and costules few, flat, entire.

Type specimen: L. S. GIBBS 5990, Arfak Mts, W. New Guinea (BM; dupl. at K, P).

Distr. *Malaysia*: W. New Guinea.

Ecol. In mossy forest, 1600–2700 m.

Note. The original specimens are fragmentary. The above description is drawn mainly from much better ones collected near the original locality by KANEHIRA & HATUSIMA (n. 13499, at BO, A).

97. *Cyathea nigropaleata* HOLTUM, Kew Bull. 16 (1962) 59.

Trunk of type 1.2 m, bearing 12 mature fronds and 8 young ones; fronds 200 cm long. Stipe warty, very dark at base, paler upwards; scales near base 20 by 2 mm, nearly black, shining, with narrow dull brown edges bearing scattered long dark setae. One pair of pinnae 6 cm long 20 cm from base of stipe, next pair much larger and higher; longest pinna 45 cm long (collector). Largest pinnules 55–80 by 12–17 mm, lowest with stalks 2–4 mm long, lowest 2 or more segments constricted at base and separated by a costal wing from the rest, rest of pinnule lobed to within 1 mm of costa; costules 3–4½ mm apart; veins 6–8 pairs; lamina-segments firm, rather pale, strongly crenate where fertile. Sori near costules; indusium a small lobed dark scale on costular side, hidden by sporangia; paraphyses a little longer than sporangia, some 2 cells wide at base. Scales and hairs: pinna-rachis pale, minutely warty and glabrescent on lower surface, dark-hairy above; costal scales rather sparse, flat, ovate to elongate, the larger with dark centre and pale edges sometimes with 1 or 2 setae; costular scales thin, light brown, flat, not fringed, setae rare.

Type specimen: PULLEN 666, Eastern Highlands, NE. New Guinea, (L).

Distr. *Malaysia*: Eastern New Guinea (2 collections).

Ecol. In *Nothofagus* forest, 2000 m.

**98. *Cyathea microchlamys* HOLTUM**, Kew Bull. 16 (1962) 58.

Stipe 45 cm, base dark, paler upwards, finely warty; scales near base to 15 by 1 mm, dark, shining, with pale edges bearing dark setae. Lowest pinna 24 cm long, longest 27 cm. Largest pinnules 65 by 13–15 mm, sessile, short-acuminate, lobed almost to costa, lowest segment not free; costules 4 mm apart; veins to 9 pairs; lamina-segments thin, minutely crenate, apices obtuse, sinuses narrow. *Sori* near costules; indusium a scale  $\frac{1}{2}$  mm wide on costular side of receptacle; paraphyses as long as sporangia. *Scales and hairs*: lower surface of pinna-rachis bearing scattered crisped hairs, also scattered flat narrow entire brown scales; costal scales sparse, flat, brown, entire; some scattered pale crisped hairs also on costae beneath; no costular scales seen (specimen is entirely fertile).

Type specimen: RAMOS BS 30475, Catanduanes, Luzon (US; dupl. at P).

Distr. *Malaysia*: Philippines (Luzon, one collection).

Note. This appears to be very near *C. caudata*, but has a long stipe and small indusia.

**99. *Cyathea perpunctulata* (v. A. v. R.) DOMIN**, Acta Bot. Bohem. 9 (1930) 146.—*Hemitelia perpunctulata* v. A. v. R. Bull. Jard. Bot. Btzg II, n. 28 (1918) 25.

Stipe unknown. *Rachis* near base copiously finely warty on lower surface, smooth and glabrescent distally. *Pinnae* articulate to rachis and rather easily detached on drying, longest 47 cm long. *Pinnules* articulate to pinna-rachis, largest 90 by 17 mm, sessile, acuminate, lobed nearly to costa, basal segment not free; costules  $3\frac{1}{2}$  mm apart; veins 10 pairs; lamina-segments rather thin, crenate, apices rounded, sinuses narrow. *Sori* near costules; indusium a small brown scale on costular side of receptacle, covered by sporangia; paraphyses not seen, certainly no long ones present. *Scales and hairs*: lower surface of pinna-rachis glabrescent, residual scales few, very narrow, dark, entire; scales on lower surface of costae near base numerous, elongate, firm, brown with pale edge, entire, grading to similar scales bullate at base and distally to many pale bullate acuminate entire scales; scales on costules bullate.

Type specimen: BÜNNEMEIJER 1219, Bt Kabung, Lubu Sikaping, Sumatra (BO; dupl. at L).

Distr. *Malaysia*: Sumatra (2 collections).

Ecol. In forest, 650 m.

**100. *Cyathea alderwereltii* COPEL**, Philip. J. Sc. 4 (1909) Bot. 50.—*Hemitelia sumatrana* v. A. v. R. Bull. Dép. Agr. Ind. Néerl. n. 18 (1908) 2; Handb. (1908) 28; Suppl. (1917) 48.—*Hemitelia horridipes* v. A. v. R. Bull. Jard. Bot. Btzg II, n. 16 (1914) 16; Handb. Suppl. (1917) 47.—*Hemitelia salticola* v. A. v. R. Bull. Jard. Bot. Btzg II, n. 20 (1915) 18; Handb. Suppl. (1917) 50.—*Hemitelia paraphysophora* v. A. v. R. Bull. Jard. Bot. Btzg III, 2 (1920) 154.—*Alsophila spinifera* v. A. v. R. *ibid.*

III, 5 (1922) 182.—*C. horridipes* DOMIN, Pterid. (1929) 264.—*C. salticola* DOMIN, l.c.—*C. paraphysophora* DOMIN, Acta Bot. Bohem. 9 (1930) 145.—*C. spinifera* DOMIN, l.c. 160.

Stipe 60 cm or more, copiously spiny at base, spines 3–4 mm long; scales to 18 by 2 mm, dark, shining, with narrow fragile edges; pneumathodes in a close double row. Lower *pinnae* somewhat reduced, longest 60 cm or more long. *Pinnules* to 90 by 18 mm, sessile, rather strongly acuminate, lobed almost to costa, basal 1–2 segments, rarely to 6 pairs, constricted at base; costules  $3\frac{1}{2}$  mm apart; veins 10–12 pairs; lamina-segments firm, rather strongly crenate, sinuses narrow. *Sori* near costules; indusium a small brown scale on costular side of receptacle, hidden by sporangia; paraphyses many, longer than sporangia, some of them 2–3 cells wide at base. *Scales and hairs*: lower surface of pinna-rachis sparsely warty, almost glabrescent, at length bearing scattered very small fringed scales and a few narrow dark ones, towards apex also some pale crisped hairs; lower surface of costae densely scaly towards base, basal scales 2 mm long, narrow, acuminate, firm, brown, entire, grading to thinner shorter ovate scales and to pale bullate scales distally; pale bullate scales abundant on costules.

Type specimen: TEYSMANN 2436, Talang Solok, Sumatra (BO; dupl. at L, K, US, U).

Distr. *Malaysia*: Central Sumatra.

Ecol. In forest at 1000–1500 m, very abundant on Mt Sago (Mt Malintang) where were collected the types of *Hemitelia horridipes* and *H. paraphysophora*. The type of *H. salticola* only differs from the others in having several basal pairs of segments on each pinnule constricted at the base, the pinnules to 22 mm wide.

**101. *Cyathea amboinensis* (v. A. v. R.) MERR.** Interpr. Rumph. Herb. Amb. (1917) 63.—*Alsophila latebrosa* var. *batjanensis* CHRIST in Warb. Monsunia (1900) 89.—*Alsophila amboinensis* v. A. v. R. Philip. J. Sc. 11 (1916) Bot. 103; Handb. Suppl. (1917) 492.

Stipe more than 50 cm, warty near base. Lower *pinnae* not greatly reduced, longest 50 cm long. Largest *pinnules* to 85 by 16–18 mm, sessile, acuminate, lobed nearly to costa, lowest segment not free; costules  $3\frac{1}{2}$ –4 mm apart; veins 10 pairs; lamina-segments firm, rather strongly crenate. *Sori* near costules; indusium a very small dark scale on costular side of receptacle; paraphyses abundant, longer than sporangia, some of them 2 cells or more wide at base. *Scales and hairs*: pinna-rachis smooth and glabrescent beneath; costae bearing many pale bullate scales almost to base, at base some flat ovate-acuminate scales; many pale bullate scales on costules.

Type specimen: C. B. ROBINSON 464, Ambon (BO; dupl. at K, A, L, BM).

Distr. *Malaysia*: Moluccas (Ambon, Ceram, Batjan), Central and North Celebes (?).

Ecol. In forest at low elevations. KJELLBERG 2088, from Malili, Central Celebes, was collected in swamp-forest at sea-level; this and a specimen

from Menado collected by POSTHUMUS are referred with some doubt to this species.

**102. *Cyathea media* WAGN. & GRETH.** Un. Cal. Publ. Bot. 23 (1948) 44, pl. 15.

*Stipe* 20–25 cm, dark, warty; scales to 20 by 1½ mm, dark to medium brown, fragile edges narrow and usually eroded. Lower *pinnæ* reduced, lowest 8–12 cm long; longest *pinnæ* 48 cm long. *Pinnules* to 85 by 15 mm, almost sessile, lobed almost to costa, 1–2 basal segments constricted at base and almost or quite free; costules 3½ mm apart; veins 8–10 pairs; lamina-segments distinctly oblique, edges crenate, apices acute or rounded. *Sori* inframedial; indusium a minute scale on costular side of receptacle, hidden by sporangia; paraphyses long. *Scales and hairs*: near base of costae some elongate flat brown scales, bullate scales also throughout; bullate scales present on costules.

Type specimen: GRETH & WAGNER 4162, Manus I., Admiralty Is (UC; dupl. at MICH).

Distr. *Malaysia*: Islands to NE. of New Guinea. Ecol. In forest, to 1600 m.

Note. I have included here specimens collected by BRASS on Goodenough Island, in mossy oak forest at 1600 m, which are smaller than the type (*pinnules* to 50 by 11 mm) but agree in other respects.

**103. *Cyathea latebrosa* (WALL. ex HOOK.) COPEL.** Philip. J. Sc. 4 (1909) Bot. 52; C. CHR. Gard. Bull. S. S. 7 (1934) 222; HOLTTUM, *ibid.* 8 (1935) 303, pl. 29, *p.p. max.*; Rev. Fl. Mal. 2 (1954) 120.—*Polypodium latebrosus* WALL. Cat. (1828) n. 318, *nomen*.—*Alsophila latebrosa* WALL. ex HOOK. Sp. Fil. 1 (1844) 37; Syn. Fil. (1866) 43, *p.p.*; BEDD. Handb. (1883) 11, *p.p.*; v. A. v. R. Handb. (1908) 38, 789, *p. p.*—*Dichorexia latebrosa* PRESL, Abh. K. Böhm. Ges. Wiss. V, 5 (1848) 344.—*Hemitelia latebrosa* METT. Fil. Hort. Lips. (1856) 111; Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 54, *p.p.*; v. A. v. R. Bull. Jard. Bot. Btzig II, n. 23 (1916) 13, *incl. var. paraphysata* v. A. v. R.; Handb. Suppl. (1917) 51, *p.p.*, 489.—*C. leucocarpa* COPEL. Philip.

J. Sc. 6 (1911) Bot. 362.—*C. longipinna* COPEL. l.c. 363.—*Alsophila leucocarpa* C. CHR. Ind. Fil. Suppl. (1913) 5; v. A. v. R. Handb. Suppl. (1917) 66.—*Alsophila longipinna* C. CHR. Ind. Fil. Suppl. (1913) 5; v. A. v. R. Handb. Suppl. (1917) 67.—*Alsophila lastreoides* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 23 (1916) 5; Handb. Suppl. (1917) 495.—*Hemitelia leptolepia* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 23 (1916) 12; Handb. Suppl. (1917) 488.—*Hemitelia rudimentaris* v. A. v. R. Bull. Jard. Bot. Btzig III, 5 (1922) 205.—*C. lastreoides* DOMIN, Acta Bot. Bohem. 9 (1930) 128.—*C. leptolepia* DOMIN, l.c. 130.—*C. rudimentaris* DOMIN, l.c. 154.

*Trunk* to c. 3 m, rather slender. *Stipe* 50 cm or more, closely short-spiny (spines 1–2½ mm long); few persistent scales, near base only, to 15 by little over 1 mm, dark, shining, fragile edges soon abraded; pneumathodes in an almost continuous row. Lower *pinnæ* somewhat reduced; longest c. 60 cm long. Largest *pinnules* 80–100 by 12–18 (–20) mm, sessile, acuminate, lobed almost to costa, lowest segment sometimes almost free; costules 3–3½ mm (rarely 4 mm) apart; veins c. 10 pairs; lamina-segments rather thin, more or less crenate, almost touching or more often separated by distinct sinuses. *Sori* near costules; indusium a small often bilobed scale on costular side of receptacle, variable in size, hidden by mature sorus; paraphyses usually longer than sporangia, some of them 2–4 cells wide at base. *Scales and hairs*: pinna-rachis sparsely warty beneath, glabrescent; costae not densely scaly, scales near base elongate, flat, brown, entire, grading to bullate scales; bullate scales on costules (most abundant on sterile *pinnules*).

Type specimen: WALLICH 318, Penang (K; dupl. at L, US, A).

Distr. Hainan, Indo-China, and Thailand, southwards to *Malaysia*: Sumatra, Malay Peninsula, Borneo.

Ecol. In forest or on edge of forest from lowlands to 1500 m.

Note. The South Indian plants formerly included here have larger thinner indusia, and should rank as a separate species not yet described.

## 2. Section *Gymnosphaera*

(BL.) HOLTTUM, *stat. nov.*—*Gymnosphaera* BL. En. Pl. Jav. (1828) 242; COPEL. Gen. Fil. (1947) 98, *p.p. (excl. sect. 3)*.—*Thysanobotrya* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 28 (1918) 66, t. 10.—*Alsophila sensu* C. CHR. Dansk Bot. Ark. 7 (1932) 37.—*Cyathea subg. Gymnosphaera* TINDALE, Contr. N. S. W. Nat. Herb. 2 (1956) 331.

Type species: *Cyathea glabra* (BL.) COPEL.—Fig. 19–21.

Distr. Madagascar; India and Ceylon, eastwards to southern China and Formosa; throughout *Malaysia*, eastwards to Fiji, and in NE. Australia. *Alsophila salvinii* HOOK. of Guatemala has dark axes, reduced fertile *pinnules* and no indusia, but it may not be closely related to Malaysian species.

Taxon. There is no doubt that *C. glabra* and its immediate allies are a natural group of species, but none of the characters by which they are separated from *sect. Cyathea* is sharply definable, and a few species (notably *C. macgillivrayi*) appear to be intermediate. To the distinguishing characters given by COPELAND, I have added hairiness of the lower surfaces of rachises; using this as a character which may occur in *sect. Cyathea*, almost all species which are exindusiate and have hairless lower surfaces belong to *Gymnosphaera*. I have included *C. macgillivrayi* in the keys to both sections.

Ecol. The species of this section appear all to be ferns of shady forest (some even of swamp forest), not of the open. Several, as here delimited, are rather widely distributed and also variable in the degree of division of pinnules, especially of fertile pinnules. Experimental cultivation might establish how much of this variation is due to edaphic and other environmental conditions, and how much is of genetic origin. *C. biformis* (ROSENST.) COPEL. is peculiar in the genus by its scandent habit.

## KEY TO THE SPECIES

1. Reduced pinnae present at base of stipe, separated from normal pinnae.
  2. Sterile pinnules of normal pinnae c. 40 by 10 mm, fertile c. 30 by 8 mm; veins 4 pairs. **104. *C. annae***
  2. Sterile pinnules of normal pinnae 60–100 by 15–20 mm, fertile 40–100 by 11–15 mm; veins 6–10 pairs.
  3. Segments of reduced basal pinnae all with very narrow lamina, forming a wing along each side of the veins.
    4. Lower sori medial on veins, distal ones close to costule. Paraphyses slender at base, widening to scale-like apex . . . . . **105. *C. ramispina***
    4. All sori close to costules. Paraphyses thick and dark at base, tapering to apex.
      3. Segments of reduced basal pinnae all with broad lamina . . . . . **107. *C. recommutata***
  1. Reduced pinnae, separate from the rest, lacking; lower pinnae in some cases reduced gradually almost to base of stipe, the lowest sometimes with narrow segments.
    5. Fronds simply pinnate with entire pinnae (sterile) or bipinnate with few pinnae and almost entire sterile pinnules; in either case the true frond-apex short and abortive, evident above attachment of uppermost pinna.
      6. Fertile pinnules lobed almost or quite to costa . . . . . **108. *C. biformis***
      6. Fertile pinnules only slightly lobed . . . . . **109. *C. scandens***
    5. Fronds with normal apex.
      7. Pinnules almost entire.
        8. Sterile pinnules to 50 by 10 mm, on stalks to 1 mm long; bullate scales present on costules. **110. *C. rebecca***
        8. Sterile pinnules to 120 by 20 mm, on stalks to 4 mm long; no bullate scales on costules. **111. *C. glabra***
      7. Pinnules distinctly lobed.
        9. Scales on lower surface of costules bullate.
          10. Bullate scales present on lower surface of veins of sterile pinnules.
            11. Pinnules to 100 mm long with several pairs of free segments at base . . . **112. *C. hornei***
            11. Pinnules to 65 mm long without free basal segments . . . . . **113. *C. dimorpha***
          10. Bullate scales lacking on veins.
            12. Axes very dark; scales on lower surface of costae bearing many setae . . . **114. *C. lurida***
            12. Axes not very dark; scales on lower surface of costae sometimes with a few setae.
              13. Pinnules to 110 by 30 mm, cut to 2 mm from costae; costules of sterile pinnules to 6 mm apart. **115. *C. rubella***
              13. Pinnules to 70 by 20 mm, cut to within 1 mm from costa; costules of sterile pinnules to 4½ mm apart . . . . . **116. *C. macgillivrayi***
        9. Scales on lower surface of costules not bullate.
          14. Pinnules lobed almost to costa.
            15. Costal scales not setiferous . . . . . **117. *C. acrostichoides***
            15. Costal scales bearing many setae . . . . . **118. *C. schlechteri***
          14. Pinnules not lobed more than 2/3 towards costa.
            16. Scales on costae bearing lateral setae. Segments or lobes of pinnules rounded and subentire. Sori usually not converging towards apices of segments. Basal basiscopic vein from costule.
              17. Stipe and basal part of rachis persistently scaly; largest pinnules with stalks at most 2 mm; veins to 6 pairs . . . . . **119. *C. subdubia***
              17. Persistent large scales only at base of stipe; largest pinnules with stalks to 4 mm; veins 3–5 pairs **111. *C. glabra***
            16. Scales on costae lacking lateral setae. Segments of lamina deltoid and distinctly toothed. Sori converging towards apices of segments. Basal basiscopic vein often from costa. **120. *C. gigantea***

**104. *Cyathea annae*** (v. A. v. R.) DOMIN, Acta Bot. Bohem. 9 (1930) 90.—*Alsophila annae* v. A. v. R. Bull. Jard. Bot. Btzg II, n. 23 (1916) 3; Handb. Suppl. (1917) 490.—**Fig. 19c.**

Stipe dark, slender; scales to 60 by 1 mm, dark and shining with dull paler edges. Basal pinnae about 4 on each side of the stipe, all within 11 cm

from the base, lowest with very narrow lamina on each side of veins and midribs of pinnules, upper ones with pinnules to 20 by 7 mm with crenate edges; largest pinnae 24 cm long, sterile and fertile pinnules dimorphous. Sterile pinnules to 43 by 10 mm, almost sessile, base broad, apex gradually narrowed, edges lobed to 1/3 towards



Fig. 19. *Cyathea recommitata* COPEL. a. Part of pinna showing transition from fertile to sterile pinnules,  $\times \frac{2}{3}$ , b. lower surface of fertile pinnule,  $\times 4$ .—*C. annae* (v. A. v. R.) DOMIN. c. Reduced pinnae at base of stipe,  $\times \frac{2}{3}$  (a-b KUNSTLER 7130, c cult. Hort. Bog.).

costa; costules 3–3½ mm apart; veins 2–3 pairs, simple. Fertile pinnules to 30 by 8 mm, lobed  $\frac{3}{4}$  towards costa, veins commonly 2 pairs, all sori-ferous; sori without indusia. Scales and hairs: scales on lower surface of costae near base narrow, dark with pale edges not setiferous, grading to pale narrow scales and to dull brown bullate scales distally and on costules.

Type specimen: Cult. Hort. Bog. II–K–XIII–10; origin Ambon, J. J. SMITH (BO; dupl. at L).

Distr. Malaysia: Moluccas (Ambon, two collections).

Ecol. At 650 m.

Note. The original description contains no reference to the fact that the species was described from a cultivated plant, the citation being 'Amboina, J. J. Smith'; the type specimens in Herb. Bog. bear no reference to J. J. SMITH, but only the location of the plant in the garden. J. J. SMITH went to Ambon in 1900 (with BOERLAGE), and brought back many plants for cultivation at Bogor. The name *annae* commemorates Mrs SMITH.

105. *Cyathea ramispina* (HOOK.) COPEL. Philip. J. Sc. 4 (1909) Bot. 36; Sarawak Mus. J. 2 (1917) 346, 349; C. CHR. & HOLTUM, Gard. Bull. S.S.

7 (1934) 200, 220.—*Alsophila ramispina* HOOK. Syn. Fil. (1866) 42; v. A. v. R. Handb. (1908) 34; CHRIST, Ann. Jard. Bot. Btzig 20 (1906) 138.—*Alsophila burbridgei* (non BAK.) CHRIST, Ann. Jard. Bot. Btzig 20 (1906) 138, p.p.—*Alsophila hallieri* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 28 (1918) 2 (non ROSENST.).—*Alsophila amaiambitensis* v. A. v. R. l.c. 1.—*Alsophila kenepaiana* v. A. v. R. ibid. III, 2 (1920) 129.—*C. kenepaiana* DOMIN, Acta Bot. Bohem. 9 (1930) 127.—*C. amaiambitensis* DOMIN, l.c. 90.—*Gymnosphaera ramispina* COPEL. Gen. Fil. (1947) 98.

Trunk rather slender, persistently covered with the finely-divided basal pinnae attached to the persistent leaf-bases. Stipe dark, almost covered with small dull brown scales; larger scales very dark, shining, to 10 by 1½ mm, with narrow thin pale edges. Basal pinnae several pairs, all with lamina reduced to a narrow wing along veins and costae, to c. 6 by 4 cm, with c. 6 pairs of pinnules; segments of pinnules to 8 mm long; rest of stipe and rachis dark and shining, glabrescent on lower surface, pinna-rachises sometimes paler and distinctly reddish. Normal pinnae to 45 cm long. Pinnules slightly dimorphous (fertile smaller), lowest with stalks 2–3 mm long, largest 70–90 by



12–19 mm, lowest 1–2 pairs of segments sometimes almost or quite free, rest of pinnule lobed to about 2 mm from costa; costules 4–4½ mm apart; veins to 8 pairs, usually all simple; lamina firm, segments slightly crenate with rounded ends. *Sori* exindusiate, distal ones close to costule, basal ones more distant from it; paraphyses slender at base, widening abruptly to a small flat apex. *Scales and hairs*: scales on costae and costules narrow, dark, shining with pale edges which occasionally bear a dark seta, grading to pale bullate scales (sometimes with setiform apex).

Type specimen: LOBB, Sarawak (K).

Distr. *Malaysia*: Borneo.

Ecol. In rather exposed places on mountain ridges at 1800–2500 m; abundant on the main ridge of Mt Kinabalu. Also recorded at 100–170 m on sandstone hill-side in Tawau R. For. Res. Young plants do not bear the small pinnae at the bases of stipes.

Note. The type specimen of *Alsophila amaia-bitenis* v. A. v. R. has no stipe, and thus does not show the reduced basal pinnae, but agrees in other characters except that all scales seen on costules are narrow with dark setae, no bullate scales being present.

**106. *Cyathea atropurpurea* COPEL.** Philip. J. Sc. 3 (1909) Bot. 354; *ibid.* 4 (1909) Bot. 36, pl. 18.—*Alsophila atropurpurea* C. CHR. Ind. Fil. Suppl. (1913) 4.—*Gymnosphaera atropurpurea* COPEL. Gen. Fil. (1947) 98; Fern Fl. Philip. 2 (1960) 234.

Differs from *C. ramispina* in somewhat smaller size of pinnae (largest seen 30 cm long) and pinnales (to 80 by 17 mm), veins to 6 pairs, segments of lamina more strongly crenate, sori all close to the costa, paraphyses thick and dark at the base, tapering and paler distally.

Type specimen: MERRILL 6056, Mt Halcon, Mindoro (MICH; dupl. at A).

Distr. *Malaysia*: Philippines (Luzon, Mindoro, Leyte, Mindanao).

Ecol. At altitudes of 1000 m and over.

**107. *Cyathea recommutata* COPEL.** Philip. J. Sc. 4 (1909) Bot. 36; C. CHR. Gard. Bull. S.S. 7 (1934) 220; HOLTUM, Rev. Fl. Mal. 2 (1954) 125.—*Gymnosphaera squamulata* (non BL.) J. SM. ex HOOK. Gen. Fil. (1842) t. 100.—*Alsophila squamulata* HOOK. Sp. Fil. 1 (1844) 51, p.p.; BEDD. Ferns Br. Ind. (1867) t. 235.—*Alsophila commutata* METT. Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 53; BEDD. Handb. (1883) 14; v. A. v. R. Handb. (1908) 34 (non *C. commutata* SPR.).—*C. hewittii* COPEL. Philip. J. Sc. 6 (1911) Bot. 134, t. 14.—*Alsophila heteromorpha* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 16 (1914) 1; Handb. Suppl. (1917) 56; Bull. Jard. Bot. Btzig III, 2 (1920) 129, incl. *var. decomposita* v. A. v. R.—*Alsophila hewittii* v. A. v. R. Handb. Suppl. (1917) 55; C. CHR. Gard. Bull. S.S. 7 (1934) 221.—*C. toppingii* COPEL. Philip. J. Sc. 12 (1917) Bot. 51; C. CHR. Gard. Bull. S.S. 7 (1934) 220.—*Alsophila subulata* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 28 (1918) 1.—*C. heteromorpha* DOMIN, Pterid. (1929) 262.—

*C. subulata* DOMIN, Acta Bot. Bohem. 9 (1930) 164.—*Gymnosphaera recommutata* COPEL. Gen. Fil. (1947) 98.—*Gymnosphaera hewittii* COPEL. l.c.—**Fig. 19a, b, 21d.**

*Trunk* rather slender, commonly not over 3 m. *Stipes* very dark; basal scales dark, shining, with thin fragile margins, to c. 20 by 2 mm; small pale dull scales also abundant. *Reduced pinnae*, several (rarely to 9) pairs attached to lower part of stipe, largest to 10 cm long, on old fronds often reduced to their stout spine-like bases, their pinnales simple and entire or the largest slightly lobed; *largest pinnae* 40 cm. *Pinnules* dimorphous (sometimes with intermediate conditions); sterile *pinnules* commonly 60–70(–90) by 16 mm, lowest on stalks 2–3 mm long, one basal segment sometimes almost free, rest lobed about halfway to costa, apex acuminate; costules 4–4½ mm apart; veins to c. 7 pairs, simple; lamina-segments rigid, dark on upper surface, apices rounded and slightly crenate; *fertile pinnules* 6–12 mm wide, costules 3–4 mm apart, *sori* close to costules, no indusia; paraphyses dark, not longer than sporangia. *Scales and hairs*: pinna-rachis smooth and glabrescent on lower surface; scales near bases of costae narrow, dark and shining with pale edges, not setiferous, grading to brown bullate scales distally and on costules.

Type specimen: CUMING 396, Mt Ophir, Malay Peninsula (original lost; dupl. at K, BM, FI, GH).

Distr. *Malaysia*: Sumatra (central and south), Malay Peninsula, Borneo.

Ecol. Commonly at 600–1500 m, in acid peaty or sandy soil, in forest (not in exposed places); in Borneo also at 0–60 m, in swamp forest on sandy ground.

Note. The type collection of *C. hewittii* (BROOKS & HEWITT 21, Bongo Mt), both in Herb. Copel. (MICH) and at BM, is certainly referable to the present species, but another collection of BROOKS so named at Kew (s.n., Jan. 1908) is a mixture of *C. recommutata* and *C. ramispina*.

**108. *Cyathea biformis* (ROSENST.) COPEL.** Philip. J. Sc. 6 (1911) Bot. 364; *ibid.* 77 (1947) 117.—*Stenochlaena dubia* v. A. v. R. Bull. Dép. Agr. Ind. Néerl. n. 18 (1908) 26; Handb. (1908) 721; HOLTUM, Gard. Bull. S.S. 5 (1932) 250, non *C. dubia* (BEDD.) DOMIN, 1929.—*Alsophila biformis* ROSENST. in Fedde, Rep. 9 (1911) 423; v. A. v. R. Handb. Suppl. (1917) 71; BRAUSE, Hedwigia 61 (1920) 401.—*Polybotrya arfakensis* GEPP in Gibbs, Arfak (1917) 71.—*Thysanobotrya arfakensis* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 28 (1918) 66, t. 10.—*C. gibbsiae* COPEL. Philip. J. Sc. 38 (1929) 129.—*Gymnosphaera biformis* COPEL. Gen. Fil. (1947) 99.—**Fig. 20.**

*Stem* 1–1½ cm ø, climbing (clinging to supporting tree by its roots), apex and bases of stipes covered with shining very dark scales to 20 by less than 1 mm wide, long-acuminate, edges pale. *Stipe* nearly black, slightly rough and scaly near base only, rest smooth and shining. *Fronds* of two kinds, simply pinnate (always sterile) and bipinnate, the true frond-apex always short and abort-



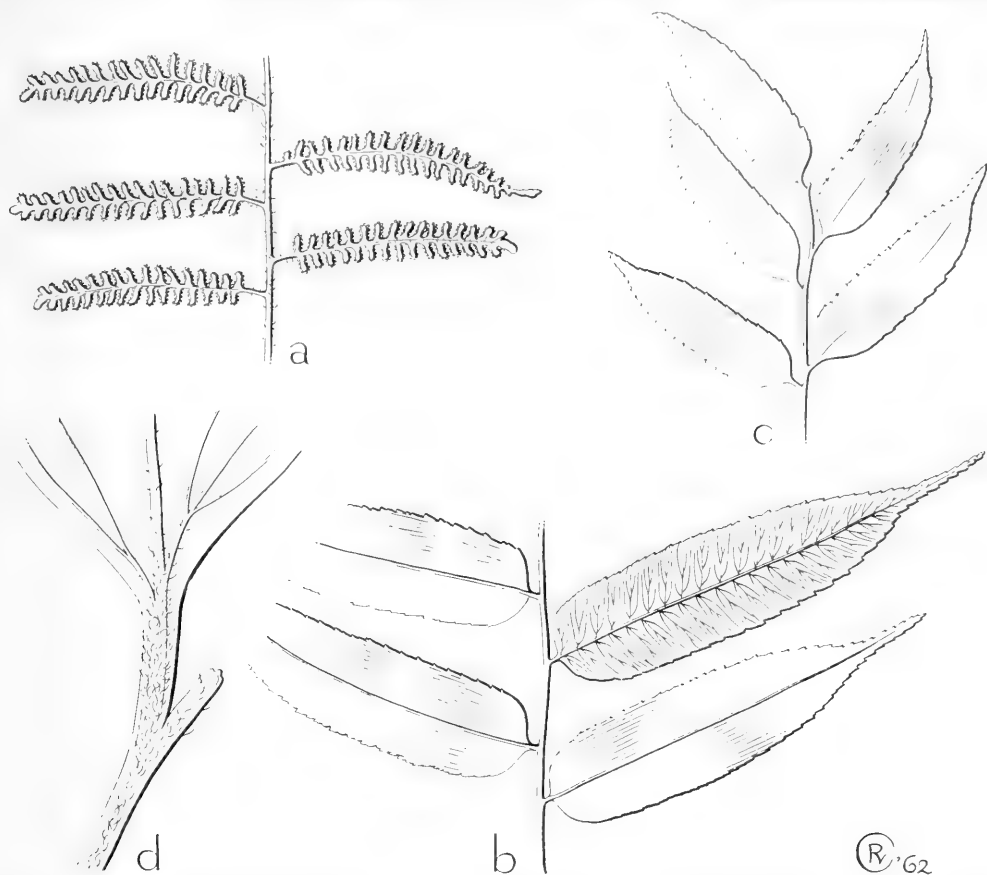


Fig. 20. *Cyathea biformis* (ROSENST.) COPEL. a. Fertile pinnules,  $\times \frac{2}{3}$ , b. sterile pinnules,  $\times \frac{2}{3}$ , c. apical part of frond, showing abortion of true apex,  $\times \frac{2}{3}$ , d. part of c,  $\times 8$  (a-b BRASS 6806, c-d BRASS 8947).

tive, evident above the attachment of the uppermost pinna, the true pinna-apex of bipinnate fronds similarly abortive. *Simply pinnate fronds* to 45 cm long (excluding stipe) with up to 17 pairs of pinnae and a false apical one; pinnae to c. 60 by 18 mm, edges deeply crenate, apex shortly caudate-acuminate, base slightly unequal, narrower and rounded acroscopically, broadly cuneate basiscopically, stalks 2 mm long, lamina firm, veins in pinnate groups, none separately from costa. *Bipinnate fronds*: stipe to 21 cm, sometimes bearing 1-2 small pinnae near the base, pneumathodes commonly 3-7 mm long, rather widely spaced; lamina to at least 100 cm long with pinnae 10-13 cm apart on each side of the rachis; pinnae to 28 cm long, lowest pinnules reduced, middle sterile pinnules stalked (2 mm), 60-90 by 15-18 mm, shaped as pinnae of simply pinnate fronds, occasionally (at high elevations) lobed  $\frac{1}{4}$ - $\frac{1}{3}$  towards costa; *fertile pinnules* stalked (3-5 mm), c. 50 by 4-10 mm, lobed almost or quite to the costa, costules  $3\frac{1}{2}$  mm apart, lobes  $1\frac{1}{2}$ -2 mm wide, entire with rounded tips, basisropic edge of

each lobe decurrent to join the lobe below it; *sori* to 4 pairs on each lobe, no indusia. *Scales on frond*: lower surfaces usually glabrous, in one case a few dark bullate scales seen on sterile leaflets.

Type specimen: COPLAND KING 57, Papua (S-PA; dupl. at MICH, BO).

Distr. *Malaysia*: Moluccas (Ambon), New Guinea.

Ecol. Climbing to 2-3 m or more, on trees in forest, at 300-2200 m, reported by BRASS to be common in mossy forest, rainforest and *Agathis* forest; PULLEN reported 'very common ground fern which often ascends trees to 8 feet', at 850 m, in *Nothofagus* forest.

Note. The only specimen with rather deeply lobed sterile pinnules is GIBBS 5984, from 2200 m (type of *Polybotrya arfakensis* GEPP).

109. *Cyathea scandens* (BRAUSE) DOMIN, Acta Bot. Bohem. 9 (1930) 156. — *Alsophila scandens* BRAUSE, Bot. Jahrb. 56 (1920) 77.

Habit of *C. biformis*, agreeing in abortive apices of frond and pinnae, differing: stipe 17 cm,

lowest pinnae 4 cm long, largest pinna 22 cm long, fertile pinnules c. 5 mm wide, shallowly lobed; elongate dark shining scales with narrow pale edges on costae, small dark bullate scales on veins of sterile pinnules.

Type specimen: LEDERMANN 9885, E. New Guinea, Sepik Region (B).

Distr. *Malaysia*: Eastern New Guinea (one collection).

Ecol. Climbing fern, at 1000 m.

Note. The type collection consists of two incomplete fronds, on two sheets. It is possible that this species should be united with *C. biformis*, but the shape of the fertile pinnules appears distinctive; the type collection bears no wholly sterile pinnules (some are sterile at the base, contracted and fertile towards apex).

**110. *Cyathea rebecca*** (F. v. M.) DOMIN, Pterid. (1929) 263; Acta Bot. Bohem. 9 (1930) 153; TINDALE, Contr. N. S. W. Nat. Herb. 2 (1956) 334. —*Alsophila rebecca* F. v. M. Fragm. 5, xxxiii (1865) 53, xxxvi (1886) 117.

*Stipe* very dark at base, finely warty after fall of scales; scales to 15 by 1½ mm, median band shining black to brown, edges thin and dull; upper part of stipe smooth purplish; pneumathodes 4–5 mm long, rather widely spaced. Lower *pinnae* gradually reduced, the lowest 10 cm or less long; several lower pairs soon caducous, leaving an apparently long stipe; largest pinnae 30 cm long (45 cm in Queensland). *Sterile pinnules* to 50 by 10 mm, on stalks to 1 mm long, edges entire or slightly unevenly crenate in basal ⅓, broadly blunt-serrate in distal ⅓; base rounded on acroscopic side, broadly cuneate on basiscopic side; lamina firm; each main lateral vein (which would be a costule in a lobed pinnule) forked alternately 3 or 4 times, the first fork at or very close to the costa. *Fertile pinnules* slightly smaller than sterile; *sori* 2–4 to a vein-group; no indusia. *Scales and hairs*: near base of costae on lower surface dark flat elongate scales with pale edges; distally on costae and on veins of sterile pinnules a few small dark bullate scales; no hairs on upper surface of costae.

Type specimen: DALLACHY, Rockingham Bay, Queensland (MEL; dupl. at K).

Distr. NE. Queensland, in *Malaysia*: Lesser Sunda Is (Flores, 3 collections).

Ecol. In Flores found at 1300–1700 m in forest; a tree fern with short trunk. In Queensland reported from sea level to 1400 m, locally abundant, a small tree-fern with trunk up to c. 3 m high, fronds to 2½ m long.

**111. *Cyathea glabra*** (BL.) COPEL. Philip. J. Sc. 4 (1909) Bot. 35; HOLTUM, Gard. Bull. S.S. 8 (1935) 316; Rev. Fl. Mal. 2 (1954) 127. —*Gymnosphaera glabra* BL. En. Pl. Jav. (1828) 242; COPEL. Gen. Fil. (1947) 98. —*Alsophila glabra* HOOK. Sp. Fil. 1 (1844) 51; METT. Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 52, p.p. (?); BEDD. Handb. (1883) 14, p.p.; RACIBORSKI, Fl. Btzig 1

(1898) 34, p.p. —*Alsophila vexans* CES. Atti Ac. Napol. 7, n. 8 (1876) 4. —*Alsophila dubia* BEDD. J. Bot. 25 (1883) 1, t. 279a; Handb. Suppl. (1892) 4; v. A. v. R. Handb. (1908) 31; Suppl. (1917) 489. —*Alsophila reducta* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 28 (1918) 1. —*C. reducta* DOMIN, Acta Bot. Bohem. 9 (1930) 153. —*C. vexans* C. CHR. Gard. Bull. S.S. 7 (1934) 218. —*Gymnosphaera vexans* COPEL. Gen. Fil. (1947) 98.

*Trunk* rather slender. *Stipe* very dark, base rough after scales have fallen; scales dark, shining, with fragile pale edges; rachis dark to purplish, smooth and glabrescent on lower surface. Lowest *pinnae* sometimes much reduced, especially on young lowland plants; largest pinnae commonly 45 cm long, to 55 cm. Largest *pinnules* 90–120 by 15–20 mm, lowest ones on stalks 2–4 mm long, base broadly rounded, apex short-acuminate, edges crenate (one crenature to each vein-group) to slightly lobed, in some cases lobed half-way to the costa; costules 4–5 mm apart; veins 3–5 pairs, usually all simple. *Sori* 1–3 (rarely 4) pairs, on each vein-group; no indusia; paraphyses slender, shorter than sporangia. *Scales and hairs*: scales on costae few, narrow, dark with pale edges which often bear a few dark setae, on costules similar but smaller, no bullate scales.

Type specimen: VAN HASSELT, Mt Karang, W. Java (L; fragment at K).

Distr. *Malaysia*: Sumatra, Malay Peninsula, Borneo, W. Java.

Ecol. In lowland swamp forest and in mountain forest to 1500 m.

Note. This species is very near *C. gigantea*, *C. subdubia* and *C. podophylla* (HOOK.) COPEL. In HOOKER's herbarium is a small fragment of true *C. glabra* from BLUME, with a good specimen of *C. gigantea*, also from Java, on the same sheet. Probably because of this, BEDDOME and others gave the name *C. glabra* to ferns from India and Ceylon which are *C. gigantea*, and when BEDDOME received the true *C. glabra* from the Malay Peninsula he re-named it *C. dubia*. *C. podophylla*, from Indo-China and S. China, has pinnules always almost entire and almost sessile, the basal basiscopic vein usually from the costa, veins of adjacent groups often slightly anastomosing, and in well-grown specimens several pairs of sori to each vein-group. HOOKER published an excellent figure of *C. podophylla* (2nd Cent. Ferns, t. 66, 1861).

**112. *Cyathea hornei*** (BAK.) COPEL. Bull. Bern. P. Bish. Mus. 59 (1929) 38; Philip. J. Sc. 77 (1947) 119. —*Alsophila hornei* BAK. J. Bot. 17 (1879) 293. —*Alsophila dissitifolia* BAK. *ibid.* 24 (1886) 182. —*Alsophila brunnea* BRAUSE, Bot. Jahrb. 56 (1920) 73. —*Alsophila ledermannii* BRAUSE, l.c. 76. —*Alsophila olivacea* BRAUSE, l.c. 74. —*Alsophila melanocaulos* v. A. v. R. Nova Guinea 14 (1924) 1. —*C. dissitifolia* DOMIN, Pterid. (1929) 262. —*C. brunnea* DOMIN, Acta Bot. Bohem. 9 (1930) 101; COPEL. Philip. J. Sc. 77 (1947) 117, 119. —*C. dimorphophylla* DOMIN, Acta Bot. Bohem. 9 (1930) 111 (new name for *Alsophila ledermannii*); COPEL.

Philip. J. Sc. 77 (1947) 117.—*C. olivacea* DOMIN, Acta Bot. Bohem. 9 (1930) 143; COPEL. Philip. J. Sc. 77 (1947) 118, 119.—*C. melanoclada* DOMIN, Acta Bot. Bohem. 9 (1930) 174 (new name for *Alsophila melanocaulos*); COPEL. Philip. J. Sc. 77 (1947) 118.—*Gymnosphaera hornei* COPEL. Gen. Fil. (1947) 99.—*Gymnosphaera melanoclada* COPEL. l.c.

*Trunk* rather slender (4 cm  $\phi$  when dry), to 3 or 4 m tall; leaf-scars to 2 cm  $\phi$ . *Stipe* to 25 cm but often much shorter, very dark, the basal part covered with dark shining pale-edged scales to 15 by 2 mm; pneumathodes 7–13 mm long. Lower *pinnae* gradually reduced, lowest commonly 10 cm long, sometimes with lamina reduced to a narrow wing along veins and costa; largest *pinnae* 40–50 cm long (60 cm reported of *Alsophila olivacea*), sterile and fertile pinnules strongly dimorphous. Largest *sterile pinnules* to 100 by 25–30 mm wide near the base, the lower ones with stalks to 3 mm, basal 2–4 pairs of segments quite free, then several pairs separately adnate to costa; costules 5 mm apart; veins to 10 pairs, mostly forked, middle ones in free segments twice forked; lamina-segments strongly crenate or the larger free ones somewhat lobed. *Fertile pinnules* to 50–60 by 11–17 mm, with basal free segments as sterile; costules  $3\frac{1}{2}$ –4 mm apart; veins usually fewer than in sterile pinnules, often forked; segments crenate, usually separated by rather wide sinuses; *sori* almost covering lower surface of fertile segments, ex-indusiate. *Scales and hairs*: pinna-rachis dark, glabrescent or bearing narrow dark pale-edged scales; scales near bases of costae elongate, dark, shining with pale edges, grading to light brown bullate scales distally and on costules; similar bullate scales also abundant on veins of sterile pinnules.

Type specimen: J. HORNE 620, Fiji (K).

Distr. Fiji, Louisiade Arch., in *Malaysia*: Eastern New Guinea.

*Ecol.* On the mainland of New Guinea at 850–2000 m, in forest; on the Louisiade islands at c. 700 m in stunted or mossy forest of ridge-crests. Small plants have pinnules almost sessile, even on the largest *pinnae*.

Note. This species is here broadly interpreted, but I cannot see any clear differences in characters of the larger *pinnae* which would warrant its subdivision. There are differences in the small basal *pinnae*, which in some cases have very narrow ultimate divisions, in others broad divisions, comparable with the difference between *C. ramispina* and *C. recommitata* in Borneo. Many specimens however lack these basal *pinnae*, and it is at present impossible to estimate whether the differences in basal *pinnae* are in any way correlated with differences in the larger *pinnae*.

**113. *Cyathea dimorpha*** (CHRIST) COPEL. Philip. J. Sc. 4 (1909) Bot. 34.—*Alsophila dimorpha* CHRIST, Ann. Jard. Bot. Btzig 19 (1904) 41; v. A. v. R. Handb. (1908) 36.

*Stipe* short. Lower *pinnae* gradually reduced, lowest less than 9 cm long; largest *pinnae* seen

30 cm long; fertile and sterile pinnules strongly dimorphous. *Sterile pinnules* to 65 by 20 mm, on stalks to 3 mm, near base lobed  $\frac{3}{4}$  towards costa, for the most part lobed only  $\frac{1}{3}$  towards costa; costules  $3\frac{1}{2}$  mm apart; veins to 6 pairs, simple; lamina-segments very firm, almost truncate, slightly crenate. *Fertile pinnules* to c. 35 by 7 mm, with stalks to 2 mm, lobed to within 1 mm of costa; costules  $2\frac{1}{2}$  mm apart; veins to 4 pairs; *sori* without indusia, paraphyses short. *Scales and hairs*: on lower surface of costae narrow shining dark scales with pale edges, not setiferous, grading to brown bullate scales on costules and veins of sterile pinnules.

Type specimen: SARASIN 2031, Bohaa Mts Celebes (BAS; dupl. at P).

Distr. *Malaysia*: Central and SE. Celebes (2 collections).

*Ecol.* At 125–645 m in SE. Celebes, at 1500–1700 m in Central Celebes.

**114. *Cyathea lurida*** (BL.) COPEL. Philip. J. Sc. 4 (1901) Bot. 45.—*Chnoophora lurida* BL. En. Pl. Jav. (1828) 244.—*Alsophila lurida* HOOK. Sp. Fil. 1 (1844) 55; v. A. v. R. Handb. (1908) 44; Suppl. (1917) 70.—*Alsophila kingii* CLARKE in Bedd. Handb. (1883) 475; v. A. v. R. Handb. (1908) 36.—*Alsophila bakeri* ZEILLER, Bull. Soc. Bot. Fr. 32 (1885) 72.—*Alsophila melanorachis* COPEL. Philip. J. Sc. 2 (1907) Bot. 146; v. A. v. R. Handb. (1908) 791.—*C. melanorachis* COPEL. Philip. J. Sc. 4 (1909) Bot. 38.—*C. kingii* COPEL. l.c. 56; HOLTUM, Gard. Bull. S.S. 8 (1935) 315, pl. 36; Rev. Fl. Mal. 2 (1954) 126.—*C. subdimorpha* COPEL. Philip. J. Sc. 8 (1913) Bot. 140, pl. 2.—*Alsophila heterophylla* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 16 (1914) 2; Handb. Suppl. (1917) 60.—*Alsophila subdimorpha* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 16 (1914) 2.—*C. heterophylla* DOMIN, Pterid. (1929) 262.—*Gymnosphaera melanorachis* COPEL. Gen. Fil. (1947) 98; Fern Fl. Philip. 2 (1960) 234.—*Gymnosphaera kingii* COPEL. Gen. Fil. (1947) 99.—**Fig. 21a–c.**

*Trunk* short. *Stipe* long (no reduced basal *pinnae*), very dark, rough near base after fall of scales; scales to 10 by  $1\frac{1}{2}$  mm, dark with pale edges; pneumathodes rather widely spaced, 6–9 mm long. *Pinnae* commonly to 50 cm long, rarely to 75 cm; pinnules strongly dimorphous, with occasional intermediate conditions. Largest *sterile pinnules* 75–110 by 16–25 mm, on largest fronds with several free basal segments, on all fronds lobed almost to the costa; stalks of lower pinnules 3–5 mm; costules  $3\frac{1}{2}$ –4 $\frac{1}{2}$  mm apart; veins to 10 pairs, mostly forked; lamina-segments firm, in the larger pinnules strongly crenate. *Fertile pinnules* 60–90 by 6–12(–17) mm wide, on stalks to 3 mm, the largest with free segments at base; costules commonly 3 mm apart, on largest fronds occasionally to 6 mm, in the latter case the segments separated by wide sinuses; *sori* ex-indusiate, almost covering lower surface of segments; receptacle much elongate; paraphyses shorter than sporangia. *Scales and hairs*: near bases of costae on lower surface narrow dark

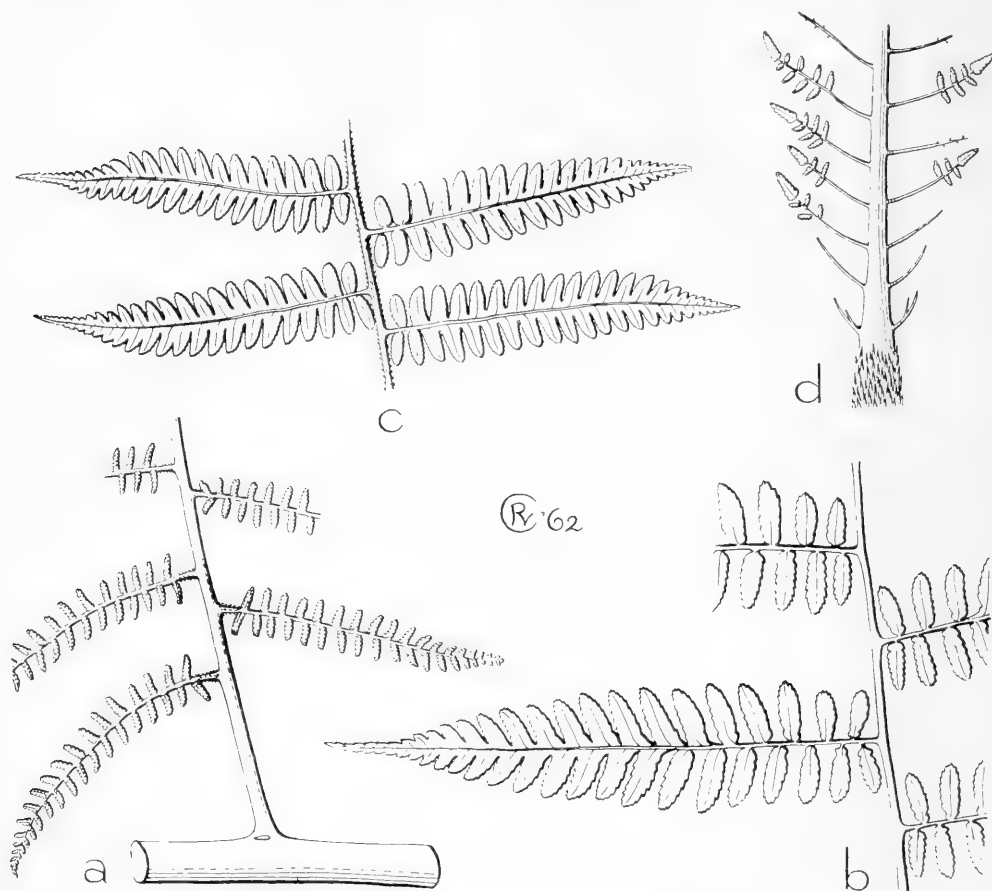


Fig. 21. *Cyathea lurida* (BL.) COPEL. *a.* Base of a fertile pinna,  $\times \frac{2}{3}$ , *b.* base of unusually large sterile pinna,  $\times \frac{2}{3}$ , *c.* normal form of sterile pinna,  $\times \frac{2}{3}$ .—*C. recommitata* COPEL. *d.* Base of frond, showing reduced pinnae,  $\times \frac{1}{4}$  (*a-c* ERYL SMITH 833, *d* after HOLTUM, *Flora of Malaya* 2, fig. 50).

scales with pale edges sometimes bearing dark setae, grading to bullate scales on costules of sterile pinnules.

Type specimen: Java, herb. BLUME (L).

Distr. *Malaysia*: Sumatra, Malay Peninsula, W. Java, Philippines (Mindoro).

Ecol. In ridge forest (not in exposed places) at 1250–1800 m. In the Malay Peninsula especially abundant on a quartzite ridge at Fraser's Hill, but absent from forest on the neighbouring granite. On granite, it occurs only on the crests of steep ridges, often in moss-forest.

Note. The type of *Alsophila melanorachis* COPEL. from Mindoro agrees in all essential characters with *C. lurida* in Malaya. No specimens of *C. lurida* have been found in Borneo, so that there is a considerable gap in distribution.

**115. *Cyathea rubella* HOLTUM**, Kew Bull. 16 (1962) 61.

Trunk to 5 m; fronds many, to 200 cm long.

Stipe 12–20 cm, the base dark purple-brown when dry, paler upwards, throughout bearing scattered slender spines 2 mm long; scales abundant near base and throughout on each side of the band of hairs on upper surface, to 25 by hardly 2 mm, dark with narrow paler edges bearing many irregular setae; small irregular dull pale scales also scattered over surface of stipe. Lower pinnae gradually reduced, lowest 6–7 cm long; longest pinnae 45 cm long. Pinnules to 110 by 30 mm (more commonly narrower), the lowest stalked 2 mm, lobed throughout to 1–2 mm from costa (lowest 1–2 segments free only on largest pinnules), apex caudate-acuminate; costules  $4\frac{1}{2}$ –6 mm apart (a little more widely spaced in sterile than in fertile pinnules); veins 8–10(–12) pairs, mostly forked, the basal basicopic vein attached well above base of costule; lamina-segments thin, somewhat tapering so that sinuses are triangular, edges crenate-serrate towards apex. Sori medial, at forks of veins or on one or both branches above the

fork in the case of basal veins; no indusia; paraphyses slender, shorter than sporangia. *Scales and hairs*: pinna-rachis reddish, paler distally, smooth apart from a few small spines, with scattered very small pale fringed scales; costae pale or somewhat suffused with red, sometimes with very small scales as pinna-rachis, larger scales sparse, flat, rather pale, apex setiform and sometimes one or more setae on the thin edges; costules bearing rather large pale bullate scales; no hairs on upper surface of costules.

Type specimen: HOOGLAND 4487, Papua, Northern District, Tufi Subdistrict (K; dupl. at BM, L, A).

Distr. *Malaysia*: East New Guinea and d'Entrecasteaux Is.

Ecol. At 650–900 m, 'common in fairly dense fairly low forest' (type); in rain-mossy forest transition in Normanby I. and in oak-rain forest transition in Goodenough I.

**116. *Cyathea macgillivrayi* (BAK.) DOMIN**, Pterid. (1929) 263; COPEL. Philip. J. Sc. 77 (1947) 109.—*Alsophila macgillivrayi* BAK. Syn. Fil. ed. 2 (1874) 458.—*C. gracillima* COPEL. Un. Cal. Publ. Bot. 18 (1942) 219; Philip. J. Sc. 77 (1947) 118, pl. 11.—*Gymnosphaera gracillima* COPEL. Gen. Fil. (1947) 99.

*Trunk* slender, to 4 m, often with bulbils growing from it or extra trunks at the base, bearing rather few fronds 100–150 cm long. *Stipe* usually 20–30 cm, in some cases only 10 cm, dark brown near base only, closely warty; scales to 15 by 1 mm, brown with narrow fragile edges. Lower *pinnae* gradually reduced, lowest 5 cm long when stipe is very short; longest *pinnae* to 40 cm. *Pinnules* commonly to 60 mm long, sometimes to 100 mm, fertile and sterile somewhat dimorphous (difference between them variable); *sterile pinnules* to 18 mm wide, costules 4–5 mm apart, veins 10 pairs, lamina-segments crenate with rounded apices, sinuses narrow; *fertile pinnules* 12–14 mm wide, costules about as in sterile pinnules but lamina-segments narrower so that sinuses are rather wide. *Sori* ± medial (at or sometimes above forks of veins, rarely on both branches of a vein), the distal ones sometimes nearer the costules; no indusium but sometimes 1 or 2 narrow scales on costular side at base of sorus; paraphyses about as long as sporangia. *Scales and hairs*: pinna-rachis pale, smooth, glabrescent, residual scales pale, largest with an occasional dark seta, smallest bearing long slender hairs, sometimes separate slender crisped hairs also present; on costae pale flat scales, elongate near base of costa, ovate and somewhat convex or bullate distally; on costules pale ovate convex or bullate.

Type specimen: MACGILLIVRAY, Louisiades (K).

Distr. *Malaysia*: New Guinea (except extreme west), Louisiade Archipelago.

Ecol. In forest, on the mainland on mountain ridges to 2000 m but apparently most abundant at lower elevations, on the islands mostly below 300 m, also on ridges, locally abundant.

Note. This species is on the border-line between

*sect. Cyathea* and *sect. Gymnosphaera*. It appears to be near *C. gregaria*, which differs in position of sori and in having dark crisped hairs and dark scales on costae.

**117. *Cyathea acrostichoides* (v. A. v. R.) DOMIN**, Acta Bot. Bohem. 9 (1930) 88.—*Alsophila acrostichoides* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 28 (1918) 2.

*Stipe* slender, copiously spiny throughout, spines 1–2 mm; *rachis* similarly spiny near base, slightly rough near apex; no scales seen on stipe and rachis. *Frond* (excluding stipe) 90 cm long; lowest *pinnae* somewhat reduced and more widely spaced; longest *pinnae* 35 cm. *Pinnules* somewhat dimorphous; largest 50–75 mm long, sterile 14–18 mm wide, fertile 9–15 mm wide, almost sessile, lowest 1–2 segments free or nearly so (except on smaller fronds), rest lobed almost to costa, apex shortly acuminate; costules  $3\frac{1}{2}$ – $4\frac{1}{2}$  mm apart; veins to 8 or 9 pairs, lower ones forked; lamina-segments crenate, or the lowest distinctly lobed, sterile separated by sinuses to 1 mm wide, fertile by sinuses to 2 mm wide (as wide as segments). *Sori* covering whole surface of segments of fertile pinnules; receptacle much raised and irregularly enlarged above the base; no indusium; paraphyses slender, shorter than sporangia. *Scales and hairs*: scales on costae flat, mostly ovate, medium brown, with some short marginal hairs; on costules smaller similar scales, more or less convex.

Type specimen: KORNASSI 541, Kaniki, Ceram (BO; dupl. at L).

Distr. *Malaysia*: Moluccas (Ceram), W. New Guinea (Japen I.).

Ecol. On Japen I. found at 650–1100 m, in forest, abundant, trunk 1–3 m tall; 'one community above a landslide which has opened the forest' (CHEESMAN).

Note. Four collections from Japen Island agree well in size and all other characters with the type from Ceram. One of them includes a small frond, fully fertile, with largest pinna 12 cm and pinnules 22 mm long. Another collection (CHEESMAN 1431, BM) consists of a much larger frond, with *pinnae* to 75 cm long, *pinnules* to 135 by 32 mm (all sterile), costules  $5\frac{1}{2}$  mm apart, veins to 14 pairs; it agrees with other specimens in shape of pinnules, in scales, and in spiny stipe.

**118. *Cyathea schlechteri* (BRAUSE) DOMIN**, Pterid. (1929) 263; COPEL. Philip. J. Sc. 77 (1947) 117, 119.—*Alsophila schlechteri* BRAUSE, Bot. Jahrb. 49 (1912) 15, f. 1D; v. A. v. R. Handb. Suppl. (1917) 61.—*Gymnosphaera schlechteri* COPEL. Gen. Fil. (1947) 99.

*Stipe* not known. *Pinnae* to 48 cm long. Sterile and fertile parts of *pinnules* strongly dimorphous (no completely sterile pinnules seen); largest pinnules 85 mm long (fertile in basal part, sterile distally), largest completely fertile pinnules 60 mm long; sterile part of pinnule 16 mm wide, lobed nearly to costa at the base, costules  $4\frac{1}{2}$  mm apart, veins 10 pairs, mostly forked; fertile part to 11 mm wide, fertile segments little over 2 mm

wide. *Sori* exindusiate, receptacle much raised. *Scales and hairs*: pinna-rachis smooth and glabrescent on lower surface, paler than main rachis; scales on costae sparse, the larger flat, ovate to elongate, pale with many long flexuous dark setae, also very small irregular pale scales; on costules setiferous scales as on costae but smaller, none bullate.

Type specimen: SCHLECHTER 17140, Kani Mts, E. New Guinea (B; dupl. at P, BM, UC).

Distr. *Malaysia*: East New Guinea (one collection).

Ecol. At 1000 m.

**119. *Cyathea subdubia*** (v. A. v. R.) DOMIN, Pterid. (1929) 263.—*Alsophila subdubia* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 20 (1915) 3; Handb. Suppl. (1917) 54.—*Alsophila persquamulata* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 28 (1918) 1.—*C. persquamulata* DOMIN, Acta Bot. Bohem. 9 (1930) 146.

*Stipe* dark, slightly warty near base after fall of scales; stipe and lower part of rachis persistently scaly on each side of the hairy median band of the upper surface; *scales* to 2 mm wide, median band dark and shining, edges pale, bearing irregular dark setae. *Pinnae* to 50 cm long, lower ones smaller. Largest *pinnules* 90–115 by 15–20 mm, almost sessile, lobed  $\frac{1}{2}$ – $\frac{2}{3}$  towards costa, apex acuminate; costules 5–6 mm apart; veins 5–6 pairs, simple, lowest basiscopic vein not from costa; lamina-segments rather thin, lobes broadly rounded and slightly crenate. *Sori* near costules, usually 3 pairs, exindusiate. *Scales and hairs*: on lower surfaces of pinna-rachis and costae smaller scales like those of main rachis (scales on costae 3 mm long); no scales seen on costules.

Type specimen: MATTHEW 672, Indrapura (G. Kerintji), Sumatra (BO; dupl. at K).

Distr. *Malaysia*: Central Sumatra, W. Java.

Ecol. At c. 1500 m.

**120. *Cyathea gigantea*** (WALL.ex HOOK.) HOLTUM, Gard. Bull. S. S. 8 (1935) 318; Rev. Fl. Mal. 2

(1954) 128.—*Alsophila gigantea* WALL. ex HOOK. Sp. Fil. 1 (1844) 53.—*Alsophila polycampta* KUNZE, Bot. Zeit. 4 (1846) 475.—*Alsophila helferiana* PRESL, Abh. K. Böhm. Ges. Wiss. V, 5 (1848) 341.—*Alsophila glabra* [non BL.] BEDD. Ferns S. India (1863) t. 60; Handb. (1883) 14; HOOK. & BAK. Syn. Fil. (1866) 43, p.p.; J. SCOTT, Trans. Linn. Soc. 30 (1874) 38; CLARKE, *ibid.* II, Bot. 1 (1880) 433; RACIBORSKI, Fl. Btzig 1 (1898) 34; v. A. v. R. Handb. (1908) 32.—*Alsophila umbrosa* WALL. ex RIDL. J. Mal. Br. R. As. Soc. 4 (1926) 6, p.p.

*Stipe* c. 50 cm, black or very dark, slightly rough after fall of scales; scales to 10 by  $1\frac{1}{2}$  mm, dark brown, shining, with narrow pale fragile edges, not setiferous; very small dull brown scales also present; pneumathodes well-spaced, 7–15 mm long. *Pinnae* commonly to 45 cm long. Largest *pinnules* short-stalked, 80–110 by 15–20 mm, evenly narrowed to apex, edges lobed  $\frac{1}{2}$ – $\frac{2}{3}$  towards costa; costules  $4\frac{1}{2}$ –6 mm apart; veins 5 or 6 pairs, simple, basal basiscopic vein of each group usually attached direct to costa; lamina-segments thin, tapering rather evenly from base so that sinuses are triangular, edges more or less strongly crenate. *Sori* exindusiate, those on basal veins widely separated from costule, on highest veins close to costule, so that each group forms an inverted V; paraphyses dark, attenuate from a thick base, shorter than sporangia. *Scales and hairs*: pinna-rachis dark purplish, smooth and glabrescent or with residual small scales like those on the stipe; scales near bases of costae firm, dark, elongate, brown with paler edges, apex setiform but no marginal setae; distally and on costules similar smaller and paler scales, none bullate.

Type specimen: WALLICH 321, Nepal, Sylhet (K).

Distr. Ceylon and S. India, NE. India southwards to Burma, Siam, Indochina; in *Malaysia*: Central Sumatra, N. part of Malay Peninsula, and W. Java.

Ecol. In rather open places from low elevation to c. 600 m.

### Subgenus *Sphaeropteris*

(BERNH.) HOLTUM, *stat. nov.*—*Sphaeropteris* BERNH. in Schrader, J. Bot. 1800, ii (1801) 122.

Type species: *Cyathea medullaris* (FORST.) SW.

Distr. Throughout Asia, Malaysia, Australasia and Polynesia. A few tropical American species have similar scales and possibly should be included in the subgenus, e.g. *C. crassipes* SOD., *C. insignis* EATON, *C. princeps* (LINDEN) MEYER, and *C. brunei* CHRIST.

Taxon. The distinction between *sect. Sphaeropteris* and *sect. Schizocaena* is on the whole quite sharp, but there are small species of *sect. Schizocaena* in Borneo which have deeply divided pinnules which, if larger, would be very like *sect. Sphaeropteris*.

### 3. Section *Sphaeropteris*

Distr. Throughout the whole range of the subgenus.—Fig. 1, 3, 4, 6, 17, 22–27.

Taxon. The division into two subsections is quite sharp, *subsect. Fourniera* being distinct in having a combination of the following characters: sori lacking indusia but covered with scales like other scales on lower surface of pinnules, and fronds fully tripinnate. Several exindusiate species of *subsect. Sphaeropteris*, however, have narrow scales spreading round the base of the receptacle of a sorus, so that the distinction on this character alone is not absolute.

3a. Subsection *Sphaeropteris*

Distr. Throughout the range of the subgenus.—Fig. 1, 3, 4, 6, 17, 22–26.

Taxon. The species of this subsection in New Guinea are difficult to characterize clearly. Sterile pinnules show the characteristic scales better than fertile ones, and are not always present on herbarium specimens. The distribution of stout pale hairs on the lower surface of pinnules is usually a distinctive character. Most species are exindusiate.

Ecol. Mostly large tree-ferns which early become established in secondary growth and will tolerate full exposure of their fronds, notably *C. contaminans* (WALL.) COPEL. (fig. 22) which is the most widely distributed *Cyathea* in Malaysia.



Fig. 22. *Cyathea contaminans* (WALL.) COPEL. in secondary growth on abandoned tea plantations, Tjibodas, with trees of *Trema amboinensis* and undergrowth of *Eupatorium inulifolium* giving ground cover (W. M. DOCTERS VAN LEEUWEN).

## KEY TO THE SPECIES

1. Indusium present.
  2. Stipe bearing many bristles 10–20 mm long, spreading at right angles, surface of bristles covered with dark setae.
    3. Slender hairs 1 mm long abundant on costae, costules and veins beneath . . . . . **121. *C. pulcherrima***
    3. Such hairs lacking; at most much shorter hairs present towards apices of pinnules. . . . . **122. *C. procera***
  2. Stipe lacking such bristles.
    4. Largest pinnules 90–120 by 16–20 mm; costae not densely scaly; no bullate scales on costae and costules . . . . . **123. *C. leucotricha***
    4. Largest pinnules 50 by 10 mm; costae densely scaly; bullate scales present on costules. . . . . **124. *C. strigosa***
1. Indusium lacking.
  5. Scales of stipe-base to 50 mm or more long, shining medium brown, rigid, edges bearing sparse rather long concolorous setae. Lamina very rigid, edges strongly reflexed and inrolled.

6. Pinnules to 30 mm long. Scales on stipe-base 2 mm wide; pinna-rachis rather persistently covered with a felt of small pale fringed scales; scales on costules bearing pale crisped marginal hairs. 125. *C. tomentosissima*
6. Pinnules 45–80 mm long. Scales on stipe-base 3–5 mm wide; pinna-rachis not persistently or densely so covered; scales on costules often bearing long dark setae.
7. Stipe bearing many dark shining spines 3–6 mm long. Pinnules to 80 mm long. 126. *C. atrox*
7. Stipe lacking spines. Pinnules commonly to 45 mm long . . . . . 126. *C. atrox* var. *inermis*
5. Scales on stipe-base mostly shorter, often not rigid and pale, edges mostly bearing close dark setae. Edges of lamina rarely much reflexed and then not inrolled.
8. Upper part of stipe and all rachises finely and very closely warty; bullate scales always present on costules.
9. Long pale hairs normally lacking on lower surface of costae and costules, present on upper surface of costules; no setiferous scales on costae . . . . . 127. *C. sangirensis*
9. Long pale hairs always rather abundant distally on lower surface of costae and costules, lacking or very few on upper surface of costules; setiferous scales present at least near base of costae.
10. Veins commonly 15 pairs; setiferous scales on costae of lower pinnules only. 128. *C. lunulata*
10. Veins 9–12 pairs; setiferous scales always abundant on costae . . . . . 129. *C. elmeri*
8. Upper part of stipe and rachises thorny or conspicuously warty, warts not very fine and close; bullate scales present or not.
11. Scales on costules abundant, copiously fringed with long crisped hairs which become entangled and form a woolly covering.
12. Scales on costules not setiferous; lamina-segments much curved forwards when dry; hairs on upper surface of pinna-rachis pale . . . . . 130. *C. tomentosa*
12. Scales at bases of costules bearing many long dark setae; lamina-segments spreading at right angles to costa; hairs on upper surface of pinna-rachis dark . . . . . 131. *C. magna*
11. Scales on costules not thus fringed.
13. Bullate scales present on lower surface of costae and or costules.
14. Bullate scales present on lower surface of veins.
15. Copious long hairs also on lower surface of veins . . . . . 132. *C. pilulifera*
15. Long hairs lacking on lower surface of veins, or only at vein-tips.
16. Pinna-rachis closely warty, warts dark; pinnules to 13 mm wide. Luzon. 133. *C. curranii*
16. Pinna-rachis sparsely thorny or warty; pinnules 15–25 mm wide. New Guinea. 134. *C. aeneifolia*
14. Bullate scales lacking on lower surface of veins.
17. Stipe conspicuously spiny; pale hairs on lower surface of costae few or lacking. 135. *C. tenggerensis*
17. Stipe warty; pale hairs abundant on lower surface of distal half of costae and on costules.
18. Costae copiously scaly throughout, with small pale-fringed scales as well as elongate setiferous ones; bullate scales not setiferous . . . . . 136. *C. persquamulifera*
18. Costae rather sparsely scaly, small pale-fringed scales lacking; bullate scales on costules setiferous . . . . . 137. *C. sarasinorum*
13. Bullate scales lacking on lower surface of costae and costules.
19. Pale erect hairs abundant on lower surface of veins.
20. Costae bearing many much-setiferous scales; pinnules to 20 mm wide.
21. Veins flat or impressed beneath; costular scales with long brown setae. 138. *C. angiensis*
21. Veins much raised beneath; costular scales with short dark setae . . . 139. *C. verrucosa*
20. Costae bearing very few scales; pinnules commonly 20–30 mm wide. 140. *C. contaminans*
19. Pale erect hairs absent or rare (near apices of segments) on lower surface of veins.
22. Stipe-scales pale, 40–50 mm long, 4–5 mm wide at base, distal half very narrow; costular scales broad, pale, flat, short-setiferous or short-fringed . . . . . 141. *C. lepifera*
22. Stipe-scales otherwise; costular scales (if present) narrower, bearing long setae.
23. Setiferous scales abundant on costae; small scales present on lower surface of veins; no stout hairs on lower surface of costae.
24. Stipe-scales 5 mm wide. Pinnules to 25 mm wide. Veins 13–15 pairs. 142. *C. atrospinosa*
24. Stipe-scales 2 mm wide. Pinnules to 35 mm wide. Veins to 20 pairs. . . 143. *C. fugax*
23. Setiferous scales lacking or rare on lower surface of costae of mature fronds; no scales on lower surface of veins; stout pale hairs present near apices on lower surface of costae. 140. *C. contaminans*

121. *Cyathia pulcherrima* COPEL. Un. Cal. Publ. Bot. 18 (1942) 219; Philip. J. Sc. 77 (1947) 119, pl. 12.

Trunk to 10 m, 3–5 cm ø below completely caducous fronds; leaf-scars 1½ cm ø. Stipe

60–100 cm, covered closely with rigid spreading dark brown bristles 2 cm long, their surfaces covered with short dark setae, some bristles flat at apex and bearing marginal setae; lower surface of rachis bearing similar shorter bristles mixed



with stout spreading reddish to pale hairs; similar hairs on lower surface of pinna-rachis. *Lamina* 100–190 cm long; longest pinnae 55–70 cm long. *Pinnules* to 100 by 20–24 mm, lobed to a narrow wing between the segments which are separated by wide sinuses; at least half the segments constricted on acroscopic side at base; costules 4–4½ mm apart; lamina thin, the fertile segments deeply crenate or more usually lobed  $\frac{3}{4}$  towards the costule, each lobule with 2 or 3 teeth; veins to 8 pairs, forked once or twice. *Sori* one to each lobe, indusiate; indusium thin, translucent, covering the young sorus, breaking irregularly and persistent; paraphyses as long as sporangia. Pale slender spreading hairs 1 mm long abundant on both surfaces of costae, costules and veins; *scales* on lower surface of costae near base small, flat with copious dark marginal setae, most scales on costae pale and bullate at base, dark-setose towards apex (some setae are superficial), these grading to pale bullate hair-pointed scales distally and on costules.

Type specimen: BRASS 8940, east slopes of Cyclops Mts, 575 m, W. New Guinea (UC; dupl. at K, BM).

Distr. *Malaysia*: New Guinea, both west and east, and Admiralty Is.

Ecol. In forest, 100–1100 m.

**122. *Cyathea procera* BRAUSE**, Bot. Jahrb. 56 (1920) 50; COPEL. Philip. J. Sc. 77 (1947) 104.—Fig. 23.

*Trunk* up to 20 m (PULLE), bearing fronds in whorls of 6; fronds 250–350 cm long. *Stipe* densely covered with spreading bristles as in *C. pulcherrima* but these sometimes pale above the base; bristles in the adaxial groove at base of stipe flattened from near the base to form flat dark scales  $\frac{1}{3}$  mm wide with setiferous margins; very small strongly setiferous scales also on surface of stipe between bristles; upper part of stipe pale, copiously warty from bases of abraded bristles. *Rachis* finely warty on lower surface, glabrescent except for some very small scales. *Pinnae* to 65 cm long. Largest *pinnules* 85–120 by 18–23 mm wide, shape and sori as in *C. pulcherrima*. *Pinna-rachis* beneath as main rachis, upper surface bearing narrow pale dark-setiferous scales to 5 mm long with the usual antrorse hairs; *costae* beneath copiously scaly, scales small, basal ones entirely dark and shining with setae on edges, grading to distal ones and those on costules which are pale and bullate at base, apex with dark setae, or the smallest (these sometimes also on veins) with a pale fringe of fine hairs; in some cases thick pale hairs distally on lower surface of costae and costules.

Type specimen: LEDERMANN 11856, Sepik Region, 2070 m, NE. New Guinea (B).

Distr. *Malaysia*: New Guinea.

Ecol. In forest, at 1800–2400 m. PULLE noted on Mt Hellwig that this was the largest tree-fern he had seen. *C. procera* is the high-mountain counterpart of *C. pulcherrima*.

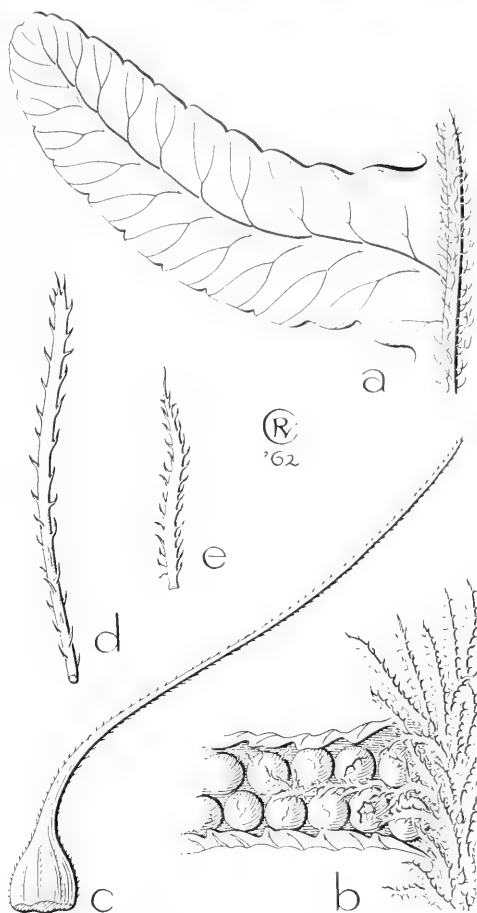


Fig. 23. *Cyathea procera* BRAUSE. a. Segment of a pinnule, upper surface,  $\times 6$ , b. part of costa and fertile segment, showing scales and sori,  $\times 6$ , c. spine from base of stipe,  $\times 4$ , d. flattened tip of stipe-spine,  $\times 13$ , e. scale from pinna-rachis,  $\times 13$  (HOOGLAND & PULLEN 5502).

**123. *Cyathea leucotricha* CHRIST**, Ann. Jard. Bot. Btzg 20 (1905) 135; v. A. v. R. Handb. (1908) 18.—*Alsophila cyclodonta* CHRIST, Ann. Jard. Bot. Btzg 20 (1905) 137.—*C. cyclodonta* v. A. v. R. Bull. Dép. Agr. Ind. Néerl. n. 18 (1908) 1; Handb. (1908) 19.

*Stipe* 50 cm, minutely warty; scales mostly caducous, dark brown with concolorous marginal setae. *Pinnae*: lowest hardly reduced, longest 60 cm. *Pinnules*: largest 90–120 by 16–20 mm, sessile or nearly so, apex acuminate, 1–3 basal segments free or nearly so (lowest may be stalked), next one or more pairs of segments contracted at base on acroscopic side, rest of pinnule lobed nearly to costa; costules 4–5 mm apart; veins 10–12 pairs; segments firm, edges crenate. *Sori* nearer costule than edge, indusiate; indusium pale and thin,

covering young sorus completely, breaking irregularly and persistent. *Scales and hairs*: pinna-rachis glabrescent; costae bearing a few small flat elongate dark-setiferous pale scales near base (some caducous) and throughout many stiff spreading pale hairs; costules bearing similar hairs, and a few on veins also; a few hairs present on upper surface of costules and veins.

Type specimen: HALLIER 2302, Borneo, Mt Klam (BO; dupl. at P, L, S).

Distr. *Malaysia*: Borneo (several widely-spaced localities).

Ecol. In forest, up to c. 700 m.

**124. *Cyathea strigosa*** CHRIST, Ann. Jard. Bot. Btzg 15 (1898) 84, t. 13, f. 6; v. A. v. R. Handb. (1908) 24.

*Stipe* 45 cm long, bearing spines 3 mm long and pale setiferous scales; main *rachis* pale beneath with many spines under 1 mm long, scales mostly caducous. *Pinnae* to 20 cm long. *Pinnules*: largest 50 by 10 mm, lobed nearly to costa, sessile; costules 3 mm apart; veins 8–9 pairs. *Sori* near costules, indusiate; indusium pale, at first covering sorus, breaking irregularly and persistent. *Scales and hairs*: pinna-rachis sparsely warty, glabrescent; costae densely scaly beneath, scales mostly bullate-acuminate, pale-fringed near apex which is a long hair, grading to long pale hairs distally, near base also some narrow pale dark-setiferous scales; costules bearing similar bullate scales and hairs; no hairs on lower surface of veins; upper surface of costules bearing a few long pale hairs.

Type specimen: WARBURG 16793, summit of Mt Wawo-Karaeng (= Bonthain), 2800 m, SW. Celebes (P?; dupl. at B).

Distr. *Malaysia*: SW. Celebes (one collection).

Note. Described from duplicate specimen at Berlin, which is sterile. This species appears to be most nearly related to *C. leucotricha* of the lowlands of Borneo.

**125. *Cyathea tomentosissima*** COPEL. Un. Cal. Publ. Bot. 18 (1942) 219; Philip. J. Sc. 77 (1948) 123, p. 15.

*Trunk* to 2½ m, 16 cm ø, bearing up to 40 fronds 60–105 cm long. *Stipe* 20–30 cm, when dry light red-brown and warty after fall of scales, base densely covered with shining firm twisted brown scales to 50 by 2 mm, edges bearing irregular concolorous short setae; above the base more or less densely covered with small scales as rachis. *Rachis* covered beneath with a close felt of very small pale scales which have flexuous marginal hairs, also with larger scales: (a) elongate flat pale scales to 1 mm wide having many brown setae near apices and often pale hairs near bases, (b) very narrow pale thin flexuous scales with slender marginal hairs; all scales more or less caducous with age. Longest *pinnae* 10–16 cm. Longest *pinnules* 30 by 8 mm, lobed almost or quite to costa; costules 2 mm apart, veins 6–7 pairs; lamina-segments very rigid, their edges much reflexed and inrolled, entire or slightly crenate. *Sori* filling cavity of lower surface of a

segment; no indusium. *Scales and hairs*: lower surface of pinna-rachis and costae as main rachis but the flat scales smaller or lacking; on costules small brown bullate scales with long crisped marginal hairs; hairs on upper surface of costae pale, with a few on costules.

Type specimen: BRASS 9116, Lake Habbema, West Central New Guinea (A; dupl. at MICH, BO, L, UC).

Distr. *Malaysia*: New Guinea.

Ecol. At 3225 m, 'along streams of open grassland, in drier shrubberies, never in forest' (BRASS).

Note. This appears to be distinct in its narrow stipe-scales and small size of frond; also in the close felt of small woolly scales on lower surfaces of all rachises, though this is more or less caducous. In other characters not clearly distinguishable from *C. atrox* var. *inermis*.

**126. *Cyathea atrox*** C. CHR. Brittonia 2 (1937) 275; COPEL. Philip. J. Sc. 77 (1947) 115.—Fig. 1, 17, 24, 25.

var. *atrox*.

*Trunk* to 6 or 7 m, bearing 20–30 fronds 125–175 cm long. *Stipe* 30–50 cm, spiny, spines dark, shining, 3–5 mm; scales near base of stipe to 50 by 3–6 mm, shining brown, firm but not very rigid, edges bearing irregular concolorous or pale hairs or setae; distal part of stipe glabrescent, light brown when dry, warty and thorny. Lower *pinnae* slightly reduced; longest 30–45 cm. Largest *pinnules* commonly 65–80 by 13–15 mm, exceptionally to 100 by 20 mm, almost all segments separately adnate to costa (a few only on pinnules of upper *pinnae*) and constricted at base, 1–2 basal ones quite free; costules commonly 3 mm apart, on largest fronds to 4 mm; veins 8–10 (–12) pairs, pale and raised on lower surface; lamina-segments rigid, edges reflexed and more or less inrolled, on distal segments entire, on largest ones rather deeply crenate, the basal free segments often deeply lobed. *Sori* nearer to costules than edge; no indusium; paraphyses short. *Scales and hairs*: pinna-rachis rather pale, warty, glabrescent, bearing residual scales as stipe but smaller; on lower surface of costae some elongate flat brown scales with dark marginal setae (these mostly caducous) and very small pale scales bearing long pale or dark marginal hairs; on costules many small brown bullate scales bearing crisped pale or dark marginal hairs; similar scales sometimes on lower surface of veins.

Type specimen: BRASS 4596, Murray Pass, Wharton Range, Papua (A; dupl. at BM, BO, BRI).

Distr. *Malaysia*: E. New Guinea.

Ecol. On edges of forest or in grassland, 2800–3600 m.

Notes. Most collections are reported as having many fronds, but two as having fronds in distinct age-groups, 6 or 7 (in a whorl) in each age-group. One of these (HOOGLAND & SCHODDE 7165) is unusually large, with pinnules 100 mm long.



Fig. 24. *Cyathea atrox* C. CHR. var. *inermis* HOLTUM in peaty grassland, Eastern Highlands, Territory of New Guinea, 3000 m (R. D. HOOGLAND).

var. *inermis* HOLTUM, var. nov.—Fig. 24, 25.

*Stipes verrucosus, vix spinosus; paleae stipitis 6–10 cm longae, ad 6 mm latae; pinnulae vulgo ad 45 × 12 mm; costulae 2½ mm inter se distantes; rhaches pinnarum subtus paleis minutis ciliatis pallidis vestitae.*

*Stipe* with numerous conical warts ½ mm high; stipe-scales 60–100 mm long, to 6 mm wide; pinnules commonly to 45 by 12 mm, edges strongly reflexed and inrolled, costules 2½ mm apart; pinna-rachis often with very small pale fringed scale.

Type specimen: HOOGLAND & SCHODDE 7457, NE. New Guinea, Western Highlands (L).

Ecol. "Commonest species in tree-fern grass-land", at 2600–2900 m. A specimen from 3500 m

(BRASS 31013) has darker, more rigid, twisted stipe-scales to 60 mm long.

Note. Two collections are reported as bearing 22–30 fronds spirally arranged, one (SCHODDE 1762) as having fronds in two whorls of 6 or 7.

**127. *Cyathea sangirensis* (CHRIST) COPEL.** Philip. J. Sc. 4 (1909) Bot. 37.—*Alsophila concinna* BAK. Syn. Fil. ed. 2 (1874) 459, non *C. concinna* (BAK.) JENM. 1891.—*Alsophila polyphlebia* BAK. J. Linn. Soc. Bot. 15 (1876) 104, non *C. polyphlebia* BAK. 1883.—*Alsophila sangirensis* CHRIST in Warb. Monsunia 1 (1900) 90.—*Alsophila scaberula* CHRIST in K. Sch. & Laut. Fl. Deut. Schutzgeb. Südsee (1901) 110; v. A. v R. Handb. (1908) 35.—



Fig. 25. *Cyathea atrox* C. CHR. var. *inermis* HOLTUM on the Sugarloaf complex, Western Highlands (R. D. HOOGLAND).

*C. scabriseta* COPEL. Philip. J. Sc. 9 (1914) Bot. 2; *ibid.* 77 (1947) 111.—*Alsophila okiana* v. A. v. R. Bull. Jard. Bot. Btztg II, n. 23 (1916) 4; Handb. Suppl. (1917) 494.—*Alsophila rumphiana* v. A. v. R. Philip. J. Sc. 11 (1916) Bot. 104; Handb. Suppl. (1917) 491.—*Alsophila scabriseta* v. A. v. R. Handb. Suppl. (1917) 73.—*C. rumphiana* MERR. Interpr. Rumph. Herb. Amb. (1917) 63.—*Alsophila buruensis* ROSENST. Med. Rijksherb. n. 31 (1917) 1.—*C. okiana* v. A. v. R. Bull. Jard. Bot. Btztg II, n. 28 (1918) 14.—*Alsophila scaberulipes* v. A. v. R. Nova Guinea 14 (1924) 2.—*C. eminens* DOMIN, Pterid. (1929) 262 (new name for *Alsophila concinna* BAK.); COPEL. Philip. J. Sc. 77 (1947) 116.—*C. aruensis* DOMIN, Pterid. (1929) 262 (new name for *Alsophila polyphlebia* BAK.); COPEL. Philip. J. Sc. 77 (1947) 115.—*C. scaberula* DOMIN, Pterid. (1929) 263; COPEL. Philip. J. Sc. 77 (1947) 109.—*C. brassii* COPEL. J. Arn. Arb. 10 (1929) 175; Philip. J. Sc. 77 (1947) 111.—*C. buruensis* DOMIN, Acta Bot. Bohem. 9 (1930) 102.—*C. scaberulipes* DOMIN, l.c. 174.

Trunk stout, to at least 8 m. Stipe long (apparently to 100 cm), pale, finely warty, persistently scaly near base; scales pale, thin but firm, finely acuminate, to c. 30 by 2 mm, edges closely set with dark setae. Lamina to 300 cm or more long. Main rachis beneath pale and finely warty, sometimes with residual spreading very narrow setiferous scales or hairs. Pinnae: largest about 75 cm long, lowest not greatly reduced. Pinnules: largest 120 by 25 mm, sessile, lowest 1 or 2 segments usually free, rest of pinnule lobed almost to costa; costules 4–4½ mm apart; veins commonly 15 pairs in largest segments; segments of lamina thin, strongly crenate (the largest crenae, where a vein is forked, slightly notched). Sori rather near costules; no indusium; paraphyses slender, dark at base and pale distally, a little longer than sporangia; a ring of very narrow ciliate pale scales round base of sorus. Scales and hairs: pinna-rachis minutely warty, glabrescent or with very small pale scales which do not bear setae; costal scales small, pale, appressed, more or less elongate, bearing pale short marginal hairs; costular scales pale bullate; a few stout pale hairs rarely present near apices of costae and costules on lower surface, these normally lacking; upper surface of costules and veins bearing scattered stout pale hairs, and similar hairs on edges of segments at apices of some veins (these latter early caducous).

Type specimen: WARBURG 16605, Sangir (= Sangehe) I. (P?; dupl. at B).

Distr. Malaysia: Moluccas (Sangehe I. (NE of Celebes), Buru, Ambon, Aru Is), throughout New Guinea, and Louisiades (Sudest I.).

Ecol. A large lowland tree-fern, in secondary growth and in open places in forest; often near rivers. In Sudest I. common at junction of rain-forest with mangrove (BRASS).

Note. MERRILL (l.c.) has suggested that *Palmifilix alba* RUMPH. (Herb. Amb. 6, 63) is to be regarded as representing this species, but the data given by RUMPHIUS are not adequate for a certain identification.

128. *Cyathea lunulata* (FORST.) COPEL. Bull. Bern. P. Bish. Mus. 59 (1929) 37; C. CHR. *ibid.* 177 (1943) 29.—*Polypodium lunulatum* FORST. Prod. (1786) 83, n. 456.—*Alsophila lunulata* R. BR. Prod. (1810) 158; HOOK. Sp. Fil. 1 (1844) 51; Syn. Fil. (1868) 41, p.p.; CARR. in Seem. Fl. Vit. (1873) 333.—*Alsophila vitiensis* CARR. in Seem. Fl. Vit. (1873) 170.—*Alsophila naumannii* KUHN, Forschungsgr. Gazelle 4 (1889) Farne 13; v. A. v. R. Handb. Suppl. (1917) 59.—*C. naumannii* DOMIN, Pterid. (1929) 263.—*C. vitiensis* DOMIN, Acta Bot. Bohem. 9 (1930) 170.

Stipe smooth or finely warty; scales to 30 by 1½ mm, pale, thin, with a few dark marginal setae. Pinnules to at least 120 by 20 mm; costules 3½–4½ mm apart; segments of lamina distinctly crenate-serrate; veins to 15 pairs. Sori exindusiate; paraphyses shorter than sporangia, usually dark when dry. Scales and hairs: pinna-rachis pale, beneath smooth or slightly prickly, quite glabrescent; costae bearing stout pale hairs distally on lower surface, scales mostly deciduous except a few very small ones; costules bearing similar hairs and also scales which are bullate and more or less fringed, or on lower pinnules may be setiferous; minute hairs sometimes visible on lower surface of veins; hairs on upper surface of costules rare.

Type specimen: FORSTER, Pacific (Göttingen; dupl. at BM).

Distr. Solomon Is, New Hebrides, Tonga, Fiji Samoa, in Malaysia: Bismarck Arch.

Ecol. Apparently a large tree-fern of low country.

Note. The type specimen is labelled "In Societatis Ins.?" but a distribution extending to Tahiti seems improbable.

129. *Cyathea elmeri* COPEL. Philip. J. Sc. 4 (1909) Bot. 54; Fern Fl. Philip. 2 (1960) 233.—*Alsophila comosa* (non WALL.) CHRIST, Ann. Jard. Bot. Btztg 15 (1898) 80.—*Alsophila latebrosa* (non WALL.) var. *major* CHRIST, Philip. J. Sc. 2 (1907) Bot. 183.—*Alsophila elmeri* COPEL. in Elmer, Leaf. Philip. Bot. 2 (1908) 419; v. A. v. R. Handb. Suppl. (1917) 66.—*Alsophila christii* v. A. v. R. Handb. (1908) 42 (non SOD. 1908); Suppl. (1917) 69, 70.—*C. dimorphotricha* COPEL. in Elmer, Leaf. Philip. Bot. 5 (1913) 1681; Fern Fl. Philip. 2 (1960) 230.—*Alsophila subcomosa* C. CHR. Ind. Fil. Suppl. 1 (1913) 5.—*Alsophila dimorphotricha* v. A. v. R. Handb. Suppl. (1917) 61.—*C. subcomosa* DOMIN, Pterid. (1929) 263.—*Alsophila fennicis* [non (COPEL.) C. CHR.] POSTH. in Holthuis & Lam, Blumea 5 (1942) 153, p.p.—*C. argyrolepis* COPEL. Philip. J. Sc. 81 (1952) 17; Fern Fl. Philip. 2 (1960) 227.

Stipe 30 cm or more, the base densely scaly, closely warty when scales have fallen; scales 25 by 1½ mm, medium brown, thin but firm, shining, acuminate, edges throughout closely set with short concolorous setae. Main rachis, lower surface, pale, closely warty, glabrescent. Pinnae to at least 60 cm long. Pinnules 90–130 by 13–25 mm, sessile, lowest 2 segments of the largest free,

next few segments separately adnate to costa, rest (whole of smaller pinnules) lobed nearly to costa; costules 3—4½ mm apart; veins 9–12 pairs; lamina-segments rather thin, strongly crenate-serrate, sinuses narrow. *Sori* near costules; no indusium; paraphyses dark, not usually longer than sporangia. *Scales and hairs*: pinna-rachis beneath pale, finely warty, glabrescent, the smallest residual scales pale with a short pale fringe, larger ones with setiferous edges; on costae near base narrow scales with long dark marginal setae, on distal half more or less abundant stout pale spreading hairs; on costules bullate-based broad scales, the larger bearing dark setae near apex, the distal ones wholly bullate and lacking setae; hairs also more or less abundant on costules; on upper surface of costules no hairs, or in some cases a few.

Type specimen: ELMER 9457. Cuernos Mts, Negros (MICH; dupl. at US, BO, F, K, P, L, U, SYD).

Distr. *Malaysia*: Philippines (Mindanao, Leyte, Negros, Biliran), Talaud Is, and N. Celebes.

Ecol. In forest at 500–1400 m.

Notes. The specimen from Talaud Is (LAM 3319), listed as *Alsophila fenicis* by HOLTHUIS & LAM, appears to lack hairs on lower surface of costae, but its setiferous scales are like those of *C. elmeri*, not of *C. sangirensis*.

The type specimen of *C. argyrolepis*, from an exposed place on Camiguin de Mindanao, has small pinnules (to 90 by 11 mm) and is more scaly than normal.

*C. haenkei* (PR.) MERR. from Guam is very nearly allied.

**130. *Cyathea tomentosa* (BL.) ZOLL. & MOR.** in Moritzi, Syst. Verz. (1846) 108.—*Chnoophora tomentosa* BL. En Pl. Jav. (1828) 244.—*Chnoophora lanuginosa* JUNGH. Tijds. Nat. Gesch. & Physiol. 8 (1841) 372; Flora 30 (1847) 522.—*Alsophila tomentosa* Hook. Sp. Fil. 1 (1844) 55; RACIB. Fl. Btzg 1 (1898) 32; v. A. v. R. Handb. (1908) 43; Suppl. (1917) 493; BACKER & POSTH. Varenfl. Java (1939) 30.—*Alsophila lanuginosa* PR. Epim. Bot. (1851) 29.—*Alsophila crinita* (non Hook.) v. A. v. R. Handb. (1908) 40.

*Trunk* to 15 m, older parts showing leaf-scars 4–4½ cm ø. *Stipe* to at least 50 cm, densely scaly throughout, spines short; scales on stipe light brown, shining, firm, 30–45 by 1–3 mm, edges bearing close dark setae throughout. *Lamina* to 250 cm long; main rachis rather closely warty with more or less persistent smaller scales. *Pinnulae*: largest to 70 cm or more long. *Pinnules* to 110 by 20 mm, of plants in exposed places sometimes only 60 by 10 mm wide; basal 1 or 2 segments of lowest pinnules quite free, then 1–2 pairs separately adnate to costa, rest of pinnule lobed almost to costa, apex acuminate; costules 3–4 mm apart; veins 10–12 pairs; lamina-segments very firm, edges usually reflexed when dry, crenate. *Sori* nearer costule than edge; no indusium; paraphyses slender, not longer than sporangia. *Scales and hairs*: pinna-rachis closely warty and

more or less persistently scaly on lower surface, scales strongly setiferous, the larger ones long and narrow; costae densely scaly throughout, scales near base long and narrow, flat, strongly setiferous (setae long and dark), grading to smaller long-fringed scales towards the apex; costules densely covered with pale elongate pale-fringed scales, the hairs of the fringes crisped and entangled, at least the distal scales with a bullate base; stout spreading pale hairs present on lower surface towards apices of costae and costules and scattered on lower surface of veins; a few also on upper surface of costules; hairs on upper surface of pinna-rachis always pale.

Type specimen: BLUME, Mt Gedeh, Java (L).

Distr. *Malaysia*: Java, Lesser Sunda Is (Flores).

Ecol. At 2200 m and over, in ridge forest and in open swampy places in gullies (abundant near hot springs at 2200 m on Mt Gedeh, West Java).

Note. *C. crinita* (HOOK.) COPEL., of Ceylon and South India, is very closely related to *C. tomentosa*. It occurs at lower elevations, is less scaly generally, the pinnules are wider, the lamina less rigid, the hairs on scales of costules straighter and less entangled. Specimens from Java formerly recorded as *C. crinita* are *C. tomentosa*; if the two species should be united, *C. tomentosa* is the older name.

**131. *Cyathea magna* COPEL.** Un. Cal. Publ. Bot. 18 (1942) 218; Philip. J. Sc. 77 (1947) 110, pl. 7.—*Alsophila tomentosa* var. *novoguineensis* ROSENST. in Fedde, Rep. 5 (1908) 34.—*C. ordinata* COPEL. Philip. J. Sc. 77 (1947) 109.

*Trunk* to 8 m; fronds 8–14, spirally arranged. *Stipe* 40–90 cm, medium brown when dry, near base more or less spiny, spines 3–5 mm long, finely warty between the spines; large scales abundant and persistent near base only, pale or in part medium brown, firm and shining, to 50 by 1½–(2) mm, edges closely set throughout with short dark setae; rest of stipe ± persistently covered with smaller pale to brown scales, the larger freely dark-setiferous, the smallest fringed with pale hairs. *Lamina* to nearly 300 cm long; main rachis on lower surface light brown when dry, rather closely warty and scaly as upper part of stipe. *Pinnulae*: largest 90 cm long. *Pinnules* mostly rather stiffly spreading almost at right angles to pinna-rachis, largest 100–140 by 14–20 mm, sessile, acuminate, lobed almost to the costa (lowest lobe sometimes just free but adnate by its lamina); costules of large fronds 4 mm apart, of smaller ones 3 mm; veins 10–12 pairs, pale and prominent beneath, not raised above; segments of lamina thick, stiffly spreading when dry, edges often rather much reflexed on drying, finely crenate to almost entire. *Sori* nearer costule than edge; indusium lacking; paraphyses not longer than sporangia, no scales round base of sorus. *Scales and hairs*: pinna-rachis beneath pale, scaly as main rachis; costae beneath densely scaly, scales near base like the larger ones of pinna-rachis, flat and elongate, strongly setiferous, smaller and narrow scales bearing long flexuous dark marginal setae present almost throughout (smallest have pale

marginal hairs); *costules* densely scaly, scales near base narrow flat and bearing long dark setae, rest light brown with  $\pm$  bullate base and long pale flexuous marginal hairs; erect hairs present distally on costules and on lower surface of veins; upper surface of costules not hairy; hairs on upper surface of pinna-rachis dark except towards apex of frond.

Type specimen: BRASS 11278, Bele R., 18 km NE of Lake Habbema, 2250 m, W. New Guinea (A; dupl. at MICH, BO, K, BM, L, UC).

Distr. *Malaysia*: New Guinea.

Ecol. In open places in forest or in grassland, 1700–2750 m.

Note. This species is closely allied to *C. tomentosa* of Java, differing in narrower and firmer stipe scales, more rigid pinnules, and a greater preponderance of small scales bearing long dark setae, these giving a darker aspect; the hairs on upper surface of pinna-rachises are also dark.

**132. *Cyathea pilulifera*** COPEL. Un. Cal. Publ. Bot. 18 (1942) 219; Philip. J. Sc. 77 (1947) 112, pl. 9.

*Stipe* 50 cm, basal part copiously spiny, spines dark, to 5 mm; scales pale, to 25 by 2 mm, edges bearing sparse dark setae or concolorous hairs; main rachis spiny, glabrescent; pinna-rachis sparsely spiny or warty. *Lamina* c. 100 cm long; longest pinnae 45 cm. *Pinnules* to 110 by 20 mm, lowest segment just free, rest lobed almost to costa; costules 4 mm apart, distinctly curved; lamina-segments firm, close, edges crenate; veins 12–14 pairs, mostly forked, lowest basiscopic vein sometimes from costa. *Sori* exindusiate; paraphyses not longer than sporangia; scales present round base of receptacle. *Scales and hairs* on lower surface of costae, costules and veins: flat pale scales with many long dark setae present near bases of costae and smaller ones distally and on costules; pale bullate scales with some setae present on distal part of costae and on costules and veins; stout pale hairs abundant on distal part of costae and on costules and veins; upper surface of costules and veins glabrous.

Type specimen: BRASS 11492, 18 km NE. of Lake Habbema, 2200 m, W. New Guinea (A; dupl. at BM, BO, MICH).

Distr. *Malaysia*: Moluccas (Ceram), New Guinea, and Louisiades.

Ecol. At 1250–2750 m; at some lower elevations reported in forest with tall trunk, at higher elevations in open places (the type in young secondary growth on old garden land, with short trunk).

**133. *Cyathea curranii*** COPEL. Philip. J. Sc. 3 (1909) Bot. 356; *ibid.* 4 (1910) Bot. 52; Fern Fl. Philip. 2 (1960) 231.—*Alsophila curranii* C. CHR. Ind. Fil. Suppl. I (1913) 5; v. A. v. R. Handb. Suppl. (1917) 70.

*Trunk* 3 m, 20 cm  $\phi$ ; leaf-scars 3 cm  $\phi$ . *Stipe* 35 cm, pale, warty, bearing light brown shining scales to 60 by 4 mm, their edges bearing rather few concolorous setae. *Lamina* 100 cm long. Lower

*pinnae* long-stalked, reduced and deflexed, largest 35 cm. *Pinnules* to 90 by 13 mm, lowest segments almost free; costules 3 mm apart; segments of lamina rigid, nearly entire, glaucous beneath; veins 8–10 pairs. *Sori* exindusiate, paraphyses present. *Scales and hairs*: pinna-rachis beneath closely warty (warts dark), with a few residual narrow light brown scales, their edges bearing concolorous setae; costae glabrescent; costules and veins beneath bearing scattered pale bullate scales and many very short hairs (probably bases of fallen scales); long hairs absent.

Type specimen: CURRAN & MERRITT FB 7925, Mt Banajao, 2000 m, Luzon (MICH; dupl. at P, US).

Distr. *Malaysia*: Philippines (Luzon).

Note. Specimens seen are in poor condition and do not include largest pinnae. The nearest relationship seems to be to *C. mertensiana* (KUNZE) COPEL. of the Bonin Is and *C. aeneifolia* (v. A. v. R.) DOMIN, and allied species of New Guinea and the Pacific.

**134. *Cyathea aeneifolia*** (v. A. v. R.) DOMIN, Acta Bot. Bohem. 9 (1930) 174; COPEL. Philip. J. Sc. 77 (1947) 113.—*Alsophila aeneifolia* v. A. v. R. Nova Guinea 14 (1924) 3.—*Alsophila aeneifolia* var. *subglauca* v. A. v. R. l.c. 4.—*C. curvipinnula* C. CHR. Brittonia 2 (1937) 276; COPEL. Philip. J. Sc. 77 (1947) 116.

*Trunk* to 4½ m. *Fronds* 9–12, 175–250 cm long. *Stipe* 50–60 cm, strongly spiny and scaly; spines dark and shining, to 6 mm; largest scales 30–60 by 3–5 mm, thin but firm and flat when young, rather pale shining brown, edges bearing scattered concolorous hairs or dark setae; rachis short-spiny or warty, bearing similar but smaller scales which are mostly caducous. Lower *pinnae* slightly reduced and deflexed, largest pinnae 30–60 cm. Largest *pinnules* 70–120 by 15–25 mm, sessile, lobed nearly to costa, a few lower segments almost or quite free; costules 3–4½ mm apart; lamina-segments very firm, almost entire, glaucous beneath; veins 10–12 pairs. *Sori* medial on veins, no indusium; paraphyses numerous, as long as sporangia; some narrow pale scales surrounding base of receptacle. *Scales and hairs*: pinna-rachis bearing  $\pm$  caducous pale brown scales to 15 × 1 mm, also small pale fringed scales; throughout lower surface of costae small fringed pale scales, with some elongate setiferous scales near base and bullate ones towards apex; on costules pale bullate hair-tipped scales, often with crisped marginal hairs or sometimes setae; on veins beneath small pale bullate scales more or less abundant, with lax hairs like tips of scales at apices of veins; no hairs on upper surface of costules and veins.

Type specimen: LAM 1751, W. New Guinea, near foot of Doormantop, in sunny ravine, 3240 m (BO; dupl. at US, L, U).

Distr. *Malaysia*: New Guinea.

Ecol. On forest edges or in grass-land, 2840–3240 m. LAM 1805, distinguished as var. *subglauca* v. A. v. R., was collected in a shady valley at 3200 m, and has larger thinner fronds than the type but



is otherwise similar. This species is nearly allied to *C. pilulifera* COPEL., but the latter has abundant long hairs on costae, costules and veins, and has been found at lower altitudes. Perhaps the two should be united.

*var. melanacantha* (COPEL.) HOLTUM, *var. nov.*—*C. melanacantha* COPEL. Un. Cal. Publ. Bot. 18 (1942) 219; Philip. J. Sc. 77 (1948) 114, pl. 10.

Stipe-scales to 15 by 2 mm, dark brown.

Type specimen: BRASS 9311, Lake Habbema, W. New Guinea (A; dupl. at BM, BO, UC, L, MICH).

Ecol. Occasional in forest-edge, at 3225 m.

*var. macrophylla* HOLTUM, *var. nov.*

*A typo speciei differt: frondibus ad 425 cm longis, stipitibus 200 cm longis inclusis; paleis stipitis ad 50 × 4 mm; pinnis maximis 70 cm longis, pinnulis maximis 135 × 21 mm; costulis 5 mm inter se distantibus.*

Type specimen: HOOGLAND & SCHODDE 7209, Western Highlands, NE. New Guinea (L).

Ecol. In cloud-forest at 2900 m.

**135. *Cyathea tenggerensis* (ROSENST.) DOMIN**, Acta Bot. Bohem. 9 (1930) 165.—*Alsophila haenkei var. angustata* HASSK. in Hook. J. Bot. Kew Misc. 7 (1855) 326.—*Alsophila glauca* (BL.) Hook. p.p.: v. A. v. R. Handb. (1908) 41; Suppl. (1917) 68; BACKER & POSTH. Varenfl. Java (1939) 28.—*Alsophila tenggerensis* ROSENST. Med. Rijksherb. n. 31 (1917) 1.

Stipe to at least 60 cm, warty, persistently scaly near base; stipe-scales to 45 by 2½–3½ mm, shining pale brown, firm, setiferous. *Pinnae* to at least 50 cm long. *Pinnules* to 110 by 16 mm, sessile, lobed almost to costa with 1 or 2 basal segments almost free; costules 2½–3 mm apart; lamina-segments firm, edges ± reflexed when dry, lower surface probably glaucous; veins 10–12 pairs. *Sori* exindusiate, nearer to costule than to edge, pale paraphyses present. *Scales and hairs*: pinna-rachis closely warty beneath, with some residual pale scales to 7 by ½ mm, setiferous; costae with similar shorter elongate scales near base, for the most part covered with rather large pale brown bullate scales which have a few concolorous marginal hairs; near apex of costae a few long pale hairs; costules bearing similar bullate scales and occasionally hairs; no long hairs on veins but very short appressed hairs (bases of former scales?) often conspicuous; hairs on upper surface of costules rare.

Type specimen: HASSKARL, Java (L?; not seen). Cited by ROSENSTOCK: ZOLLINGER 2541, Mt Tengger, E. Java (L; dupl. at P).

Distr. *Malaysia*: East Java, Lesser Sunda Is (Flores), South Celebes.

Ecol. In open places at 1500–2300 m; locally abundant on Mt Tengger.

Note. This species was established by ROSENSTOCK by reference to the description of *Alsophila haenkei var. angustata* HASSK., without further description; HASSKARL's specimen, for which he cites no locality, is therefore the type. The above

description is largely based on several later collections from Mt Tengger.

**136. *Cyathea persquamulifera* (v. A. v. R.) DOMIN**, Acta Bot. Bohem. 9 (1930) 146.—*C. contaminans var. persquamulifera* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 28 (1918) 13.—*Alsophila persquamulifera* v. A. v. R. *ibid.* III, 2 (1920) 130.

Stipe scaly throughout, no long spines; basal scales to 30 by 1 mm, medium brown, shining, strongly setiferous (on a young frond). *Main rachis* closely warty beneath. *Pinnae* to at least 60 cm long, lower ones rather long-stalked. *Pinnules* to 135 by 25 mm, 1 or 2 basal segments free or contacted at base, rest of pinnule cut nearly to costa, sessile, caudate-acuminate; costules 3½–4 mm apart; segments firm, edges often ± reflexed when dry, crenate; veins to at least 12 pairs, lowest from costa or base of costule. *Sori* nearer costule than margin; no indusium, thin paraphyses not longer than sporangia. *Scales and hairs*: pinna-rachis beneath bearing very small fringed pale scales and copious narrow light brown strongly setiferous ones up to 10 mm long; costae at base as pinna-rachis, the larger scales 5–6 mm long, grading to very narrow setiferous scales and some bullate hair-pointed scales, also many very long (2 mm) stout brown hairs except near base; costules bearing copious similar hairs, sometimes narrow pale scales 2–3 mm long with marginal hairs or setae, always hair-pointed pale bullate scales; veins with a few stout erect hairs on lower surface; upper surface of costules and veins glabrous.

Type specimen: BÜNNEMEIJER 961, Mt Talamau, 2300 m, Sumatra (BO; dupl. at K, L).

Distr. *Malaysia*: Central Sumatra, throughout Java.

Ecol. On mountains at 1500–2500 m.

**137. *Cyathea sarasinorum* HOLTUM**, Kew Bull. 16 (1962) 61.—*Alsophila contaminans var. longepaleata* CHRIST, Ann. Jard. Bot. Btzig 19 (1904) 42.—*Alsophila glauca var. longepaleata* v. A. v. R. Handb. (1908) 41; Suppl. (1917) 69.

*Main rachis* pale beneath, with dark shining warts bearing dark shining setiferous scales to 15 by 1 mm. *Pinnae* to 67 cm long. *Pinnules* to 90 by 18 mm, lowest 1 or 2 lamina-segments constricted at base, rest of pinnule lobed almost to costa, apex rather shortly acuminate; costules 4 mm apart; segments of lamina thin, oblique, their rounded ends curved forwards, edges crenulate; veins 9–10 pairs. *Sori* near costules, exindusiate. *Scales* on costae beneath near base very narrow, dark shining brown, with many concolorous setae, smaller distally; pale spreading hairs also present towards apex of costae and on costules, on lower surface; scales on costules dark narrow, setiferous, also pale bullate scales bearing setae near their tips.

Type specimen: F. & P. SARASIN 2105, Si-baronga-Rücken, Central Celebes (BAS).

Distr. *Malaysia*: Central Celebes (one collection).



**138. *Cyathea angiensis* (GEPP) DOMIN, Acta Bot. Bohem. 9 (1930) 90.**—*Alsophila angiensis* GEPP in Gibbs, Arfak (1917) 69.

Like *C. contaminans* (WALL.) COPEL., but rather small; pinnules 100–150 by 16–20 mm; costules  $3\frac{1}{2}$  mm apart, veins flat or impressed on lower surface; lamina-segments very firm, edges almost entire to crenate, glaucous beneath; more or less abundant pale flat setiferous scales present on lower surface of costae and costules; long pale spreading hairs more or less abundant towards apex of costae and on costules and veins on lower surface, rarely on upper surface of costules; paraphyses pale, longer than sporangia.

Type specimen: GIBBS 5968, Angi Lakes, 7000 ft, W. New Guinea (BM; K, P, BO).

Distr. *Malaysia*: Moluccas (Buru), New Guinea.

Ecol. Mountains, 600–2200 m.

Note. A specimen from Sepik District, Territory of New Guinea (DARBYSHIRE & HOOGLAND 8191) bears the following information: "fronds immediately fully deciduous, the leaf-scars in distinct orthostiches (8) ... 12 fronds in 3 whorls of 4, the outer whorl old, the middle whorl young fertile, the upper whorl not yet fully expanded, within each whorl the fronds very closely of the same age". DARBYSHIRE 384 has similar information, but fronds in whorls of 5. If I have correctly identified these specimens, the following characters distinguish this species from *C. contaminans*: fronds in whorls of 4 or 5, old fronds immediately and fully caducous. The remaining specimens referred to *C. angiensis* do not bear such information.

See also under 140. *C. contaminans*.

**139. *Cyathea verrucosa* HOLTTUM, Kew Bull. 16 (1962) 63.**

*Stipe* rather pale, closely warty throughout, persistently scaly near base only; scales to 40 by 3 mm, thin, pale, edges strongly dark-setiferous; main rachis, lower surface, glabrescent, closely warty (warts to 1 mm high). *Pinnae* to at least 60 cm long, lower ones with stalks 6 cm long. *Pinnules* to 110 by 20 mm, sessile or the lowest stalked, caudate-acuminate, basal 1–2 segments free or nearly so, rest cut almost to costa; costules  $3\frac{1}{2}$ –4 mm apart; lamina-segments rigid, edges minutely crenate, sinuses narrow; veins to 12 pairs. *Sori* at about  $\frac{1}{3}$  distance from costule to edge, marked by a depression on the upper surface, exindusiate; paraphyses pale, as long as sporangia, no scales round base of sorus. *Scales and hairs*: pinna-rachis beneath rather closely warty, bearing scattered pale setiferous scales to 10 by  $1\frac{1}{2}$  mm and very small pale setiferous or short-fringed scales; costae at first bearing many narrow pale setiferous scales to 2 mm long, these mostly caducous, also much shorter pale scales which are setiferous or the smallest pale-fringed, not bullate, distal half of costae bearing copious long pale spreading hairs with few scales; costules at first bearing many narrow pale setiferous scales to 2 mm long, also flat ovate-acute setiferous or

fringed scales, and long pale spreading hairs; veins beneath bearing stout erect hairs (2 or 3 on a vein) and very short hairs which appear to be bases of fallen scales; upper surface of costules and veins glabrous.

Type specimen: MATTHEW s.n., 3.2.1912, Mt Merapi, 5000 ft, Sumatra (K).

Distr. *Malaysia*: Central Sumatra (two collections).

Ecol. In open places in forest at 1600–1900 m.

Note. Closely related to *C. contaminans* but much more densely scaly, the stipe closely warty instead of rather sparsely spiny.

**140. *Cyathea contaminans* (WALL. ex HOOK.) COPEL. Philip. J. Sc. 4 (1909) Bot. 60; v. A. v. R. Bull. Jard. Bot. Btzig II, n. 28 (1918) 13; COPEL. Philip. J. Sc. 77 (1949) 115; HOLTTUM, Rev. Fl. Mal. 2 (1954) 119; COPEL. Fern Fl. Philip. 2 (1960) 230.**—*Polypodium contaminans* WALL. Cat. (1828) n. 320, nomen.—*Chnoophora glauca* BL. En. Pl. Jav. (1828) 243 (non *C. glauca* BORY, 1804).—*Alsophila glauca* J. Sm. J. Bot. 3 (1841) 419; BEDD. Handb. (1883) 12; v. A. v. R. Handb. (1908) 41 (incl. var. *celebica*, var. *squamulata*, var. *densa*, var. *setulosa*, and var. *microloba*); KOORD.-SCHUM. Syst. Verz. 1, 2 (1912) 5; ROSENST. Hedwigia 56 (1915) 349, incl. var. *trichocarpa* ROSENST.; v. A. v. R. Handb. Suppl. (1917) 69 (incl. var. *squamulosa*); Bull. Jard. Bot. Btzig III, 2 (1920) 129; BACKER & POSTH. Varenfl. Java (1939) 28.—*Alsophila contaminans* WALL. ex HOOK. Sp. Fil. 1 (1844) 52, t. 18, f. 2; HASSK. in Hook. J. Bot. Kew Misc. 7 (1855) 323 (incl. var. *robusta*, var. *squamulata*, var. *densa*, var. *microloba* and var. *setulosa* HASSK.); BEDD. Ferns Br. Ind. (1865) pl. 85; HOOK. Syn. Fil. (1866) 41; SCOTT, Trans. Linn. Soc. 30 (1874) 35; CHRIST, Verh. Nat. Ges. Basel 11 (1895) 199, incl. var. *celebica* CHRIST; FARNKR. Erde (1897) 327; Ann. Jard. Bot. Btzig 15 (1898) 79, pl. XIII f. 2; DIELS in E. & P. Pfl. Fam. 1, 4 (1899) 136, p.p.—*Alsophila acuta* PRESL, Abh. k. Böhm. Ges. Wiss. V, 5 (1848) 343.—*Alsophila smithiana* PRESL, l.c. 342.—*Alsophila clementis* COPEL. Philip. J. Sc. 1, Suppl. 2 (1906) Bot. 143.—*C. clementis* COPEL. *ibid.* 4 (1909) Bot. 59; Fern Fl. Philip. 2 (1960) 230.—**Fig. 3, 6, 22, 26.**

*Trunk* often very tall and much thickened by adventitious roots at base, only when old showing leaf-scars in upper part. *Stipe* to 100 cm long, glaucous, purplish towards the base, usually strongly spiny, at first scaly throughout, persistently so near the base; scales of all sizes up to 45 by 3 mm, pale brown, very thin, edges bearing close dark short setae. *Main rachis* pale, spiny, at first scaly as stipe, later  $\pm$  glabrescent. *Pinnae*: lowest somewhat reduced and with stalks to 10 cm long, largest 60 cm. *Pinnules* to c. 150 by 30 mm, often smaller, lowest distinctly stalked, largest with 1–2 pairs of basal segments more or less free, rest of pinnule lobed almost to the costa; costules commonly 4–4½ mm apart, rarely to 5 mm; segments of lamina firm, glaucous beneath, edges  $\pm$  crenate-serrate; veins commonly 12 pairs.



Fig. 26. *Cyathea contaminans* (WALL.) COPEL. in Tjibodas mountain garden (VAN STEENIS).

*Sori* near costules, lacking indusia; paraphyses pale, not longer than sporangia. *Scales and hairs*: pinna-rachis more or less spiny, pale, glabrescent; lower surface of costae at first bearing scattered pale setiferous scales to 3 by  $\frac{1}{2}$  mm, shorter distally, these in most cases early caducous leaving the costae glabrous; costular scales small,  $\pm$  ovate, pale-fringed, mostly caducous, not bullate; a few hairs normally present towards apex of pinnules on both costae and costules, their abundance varying much; in a few localities (notably Mt Kinabalu, also in New Guinea) stout erect hairs, in variable number, may be present on lower surface of veins.

Type specimen: WALLICH 320, Penang (K).

*Distr.* Throughout *Malaysia*, in Peninsular India as far N as Mergui. Specimens so named from Hong Kong are *C. lepifera* (J. SM.) COPEL.

*Ecol.* In clearings and open places in forest, especially near streams, 200 to 1600 m, often very abundant.

*Notes.* This is the most widespread species of *Cyathea* in *Malaysia*, having no close allies at low elevations in Western *Malaysia*. In New Guinea there are several allied species, of which *C. angiensis* (GEPP) DOMIN appears to be nearest; it may perhaps better be united to *C. contaminans*. The several varieties of *C. contaminans* which have been described appear mostly to be due to the influence of environmental factors, or to be

young, and therefore unusually scaly, at the time of collection.

I have only seen one specimen of this species from NE. India; it was collected by SCOTT, who noted (*l.c.*) that typical *Alsophila contaminans* occurred there only at low altitudes. He distinguished *var. brunoniana* (*A. brunoniana* Hook.), which is common in Sikkim at higher altitudes and has smooth (not spiny) stipes and copiously scaly costae and costules. I prefer to regard this as a distinct species, which must be called *Cyathea brunoniana* (Hook.) CLARKE & BAK., though this name was actually used by CLARKE & BAKER for a quite different species. I hope to publish elsewhere descriptions of this and other species of the mainland of Asia.

**141. *Cyathea lepifera*** (J. Sm.) COPEL. Philip. J. Sc. 4 (1909) Bot. 40; *ibid.* 56 (1935) 98, pl. 3, fig. 4-7; Fern Fl. Philip. 2 (1960) 228.—*Alsophila lepifera* J. Sm. *ex* Hook. Sp. Fil. 1 (1844) 54; CHRIST, Bull. Herb. Boiss. 6 (1898) 137, *incl. var. congesta* CHRIST; V. A. v. R. Handb. (1908) 39; Suppl. (1917) 65.—*Alsophila pustulosa* CHRIST, Bull. Herb. Boiss. II, 1 (1901) 1019; NAKAI, Bot. Mag. Tokyo 41 (1927) 73; ITO, Fil. Jap. III. (1944) pl. 453.—*Alsophila calocoma* CHRIST, Philip. J. Sc. 2 (1907) Bot. 182; V. A. v. R. Handb. (1908) 789.—*C. pustulosa* COPEL. Philip. J. Sc. 4 (1909) Bot. 51.—*C. calocoma* COPEL. *l.c.* 53; Fern Fl. Philip. 2 (1960) 229.—*C. umbrosa* COPEL. Philip. J. Sc. 56 (1935) 98, pl. 3, fig. 1-3.—(?) *C. pteridioides* COPEL. *l.c.* 98, pl. 4; Fern Fl. Philip. 2 (1960) 229.

*Stipe* 16 cm or more, almost wholly covered with scales, not spiny (warty when scales have fallen); scales pale, thin, to 40 by 2-4 mm wide at base, apical part narrowly acuminate, edges throughout closely setiferous, narrow apical part sometimes entirely brown; smaller scales on stipe very narrow (under  $\frac{1}{2}$  mm wide), brown, with concolorous marginal setae. *Rachis* and pinna-rachis closely conspicuously warty, pale, more or less completely glabrescent, warts darker, to nearly 1 mm high. *Pinnae*: lowest somewhat reduced; largest to at least 80 cm long. *Pinnules* 100-150 by 15-22 mm, caudate-acuminate, sessile, largest with a few free or separately adnate basal segments, the rest lobed almost to the costa; costules 3-3½ mm apart; veins 12-14 pairs; lamina-segments firm, entire or nearly so, glaucous beneath. *Sori* near costules; no indusia; paraphyses pale, longer than sporangia, some in form of narrow scales. *Scales and hairs*: pinna-rachis bearing some persistent appressed small pale fringed scales and occasionally longer spreading setiferous scales; costae beneath more or less densely scaly, basal scales elongate, narrow, pale with dark setae, distal ones smaller with pale marginal hairs, all flat, also some very small pale fringed scales throughout; at least the apical part of each costa also bearing stout pale hairs beneath; costules beneath bearing pale flat ovate to elongate scales bearing short pale marginal hairs, also more or

less abundant stout spreading pale hairs; upper surface of costules lacking hairs.

Type specimen: CUMING 180, Luzon (K; dupl. at BM, F, A, BO).

Distr. Ryukyu Is, Formosa, Kwangtung, Hong Kong, in *Malaysia*: Philippines (Luzon, Panay, Mindoro, Babuyan).

Ecol. In the Philippines a mountain species, but herbarium labels bear little ecological information. I have been unable to find the type specimen of *C. pteridioides* COPEL.; it is not in COPELAND's herbarium.

**142. *Cyathea atrosinosa*** HOLTUM, Kew Bull. 16 (1962) 52.

*Trunk* 6 m; fronds 350 cm long, in whorls of 4, 5 or 6, usually two whorls green at one time. *Stipe* to 125 cm long, lower part armed with dark spines to 8 mm long, also densely covered with scales which are up to 30 by 5 mm, thin, pale or pale brown, their edges bearing concolorous short hairs or dark setae. *Rachis* pale and glabrescent on lower surface, with scattered small thorns. *Pinnae* to 80 cm long. *Pinnules* to 120 by 25-30 mm, lowest on stalks up to 5 mm, lobed almost to the costa with the 1-2 lowest segments more or less free; costules 3½-4 mm apart; lamina-segments crenate, apices rounded, sinuses between them about 1 mm wide; veins 13-17 pairs. *Sori* exindusiate; paraphyses numerous, longer than sporangia. *Scales and hairs*: pinna-rachis pale beneath, glabrescent or with scattered setiferous scales; scales near base of costae shining brown, ovate, flat, long-setiferous, towards apices paler fringed scales; costules bearing pale brown flat fringed scales, and a few similar smaller ones also on lower surface of veins.

Type specimen: HOOGLAND & PULLEN 6090, Western Highlands District, 2650 m, NE. New Guinea (K).

Distr. *Malaysia*: E. New Guinea.

Ecol. In mountain forest, on limestone (always?) at c. 2400-2850 m.

**143. *Cyathea fugax*** v. A. v. R. Bull. Jard. Bot. Btzg II, n. 7 (1912) 8; Handb. Suppl. (1917) 34; COPEL. Philip. J. Sc. 77 (1947) 116.

*Trunk* to 10 m; fronds up to 300 cm long; leaf-scars 4 cm  $\alpha$ , in alternate whorls of 5 (BRASS 25585, Normanby I.). *Stipe* to at least 40 cm, spiny and rather densely scaly for most of its length; spines 2 mm or more long; scales pale, thin, to 25 by 2 mm, bearing many dark marginal setae near apices. *Pinnae* to 70 cm or more long. *Pinnules* to 145 by 35 mm, lowest 1-2 segments free, then some separately adnate, rest of pinnule cut nearly to costa, apex caudate-acuminate; costules 4½ mm apart; lamina-segments rigid, glaucous beneath, little over 3 mm wide, almost entire; veins to 20 pairs, basisopic basal vein from costa. *Sori* nearer costules than edge, exindusiate, with a ring of narrow fringed scales round base of receptacle; long paraphyses also present. *Scales and hairs*: pinna-rachis pale, bearing scattered short thorns, glabrescent; on costae

near base pale scales (apex dark or not) bearing dark flexuous setae, grading to smaller pale fringed scales without setae (or with a few) on costules and on veins; small scales on veins with short marginal hairs; very small hairs present on lower surface between veins; no hairs on upper surface of costules.

Type specimen: COPLAND KING 215, Papua (BO; dupl. at MICH, SYD).

Distr. *Malaysia*: E. New Guinea and adjacent islands.

Ecol. In wet ground, secondary forest and open places in forest in low country up to 1400 m.

Note. Details of trunk and stipe are taken from specimens other than type. Under type number at Sydney and Brisbane are also specimens of *C. contaminans* (WALL. ex HOOK.) COPEL., which differ notably in scales from the type.

### 3b. Subsection *Fourniera*

(BOMMER) HOLTUM, *stat. nov.*—*Fourniera* BOMMER, Bull. Soc. Bot. Fr. 20 (1873) xix.—Fig. 27.

Type species: *Cyathea novae-caledoniae* (METT.) COPEL.

Distr. The centre of distribution is New Guinea, with eastward and south extension to Samoa, New Caledonia and NE. Australia, westward and north to W. Java, Celebes, North Borneo (also Pulau Tio-man) and Philippines.

Taxon. A distinction between species with long stipes and those with short stipes (the latter having gradually reduced lower pinnae) appears to be valid, but some collections do not include the stipe and so are not easy to place. More field study is needed in Eastern New Guinea.

Ecol. These appear all to be forest species.

#### KEY TO THE SPECIES

1. Pinnules 30–40 mm long; lower pinnae gradually reduced.
  2. Tertiary leaflets on stalks almost 1 mm long. Pinnae to 25 cm long. Bullate scales present on costules. **144. *C. carriei***
  2. Tertiary leaflets almost sessile. Pinnae to 45 cm long. No bullate scales on costules. **145. *C. womersleyi***
1. Pinnules commonly at least 70 mm long, in most cases much longer.
  3. Lower pinnae gradually reduced, lowest 11 cm long near base of stipe. **146. *C. auriculifera***
  3. Lower pinnae not thus reduced (sometimes 1–2 pairs of isolated small pinnae at base of stipe).
    4. Bullate scales present on costae and costules.
      5. Pinnules to 110 by 22 mm. Soral scales small, not covering sorus at maturity. **147. *C. teysmannii***
      5. Pinnules to about 65 by 16 mm. Soral scales broad, covering sorus at maturity. **148. *C. aciculosa***
    4. Bullate scales lacking.
      6. Veins and lower surface of lamina bearing finely fringed interlacing scales which cover lower surface of leaflets . . . . . **149. *C. celebica***
      6. Veins bearing at most small separate scales on lower surface.
        7. Scales absent from lower surface of veins . . . . . **150. *C. tripinnata***
        7. Scales present on lower surface of veins, not long-fringed nor covering lower surface of leaflets. **151. *C. macrophylla***

**144. *Cyathea carriei*** HOLTUM, Kew Bull. 16 (1962) 53.—Fig. 27.

*Stipe* c. 7 cm, covered with a felt of very small dull scales, the larger ones setiferous, surface where exposed dark and smooth; larger scales near base to 30 by hardly 1 mm, edges bearing short dark setae, apex a long dark seta; lower surface of *rachis* dark brown, smooth or finely warty, glabrescent or with sparse minute dull scales. Lowest *pinnae* c. 3 cm long, succeeding ones gradually longer, up to 25 cm long. *Pinnules* to 32 by 7 mm, fully pinnate; *tertiary leaflets* to c. 12 pairs, distinctly stalked (stalks to almost 1 mm long and 2 mm apart), to 4 by a little more than 1 mm, edges sinuous, lowest sometimes

deeply lobed at the base; veins 4–5 pairs. *Sori* up to 6 on each tertiary leaflet, covered to ripeness by broad pale lacerate overlapping scales which give the appearance of a complete indusium. *Scales and hairs*: pinna-rachis beneath dark, bearing many very small pale dull scales, some small bullate scales and scattered long narrow pale or partly dark closely setiferous scales; scales of pinnule-rachis (costa) small, brown, shining, mostly bullate and ending in a seta, some nearly flat and slightly elongate, rarely with lateral setae; scales of midribs of leaflets shining dark brown, bullate, acuminate, similar scales sometimes also on lower surface of veins; upper surface of tertiary leaflets glabrous.

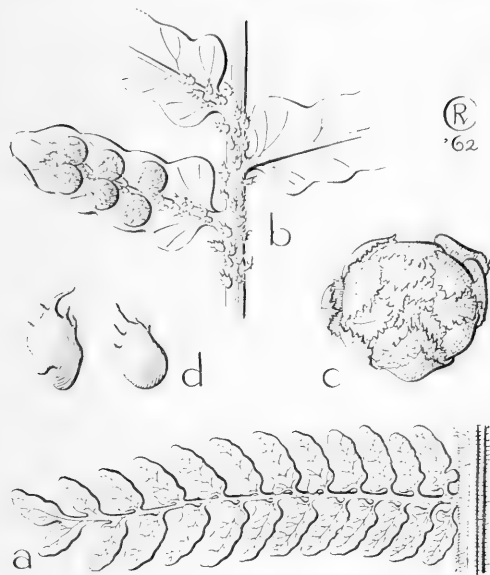


FIG. 27. *Cyathea carrii* HOLTUM. *a.* Single pinnule, upper surface,  $\times 2$ , *b.* part of pinnule, lower surface, showing scales and sori,  $\times 6$ , *c.* sorus, showing covering of overlapping scales,  $\times 20$ , *d.* scales from costule,  $\times 30$  (CARR 13526).

Type specimen: CARR 13526, in forest, Boridi, 5000 ft, Papua (K; dupl. at BM, L).

Distr. *Malaysia*: E. New Guinea (one collection).

**145. *Cyathea womersleyi* HOLTUM, Kew Bull. 16 (1962) 63.**

*Trunk* to 8 m, fronds to 10, suberect, to 300 cm long, with pinnae gradually reduced to the base. *Stipe* 8–20 cm, sparsely spiny (spines to  $2\frac{1}{2}$  mm), densely and persistently covered with scales which are pale, rather dull and soft, with a dark red seta at apex and no others, 10–20 by less than 1 mm, smaller ones 4–5 by  $\frac{1}{5}$  mm; main *rachis* persistently scaly beneath, smaller scales all with setiform apex, some elongate ones with pale edges bearing dark setae. *Pinnae*: lowest 8 cm long, longest 45 cm. *Pinnules* to 40 by 10 mm, almost fully pinnate; costules (midribs of tertiary leaflets) 2 mm apart; *tertiary leaflets* mostly 4–5 mm long, hardly stalked, slightly oblique, entire, apex rounded, base unequal, veins 6–7 pairs, lowest leaflets on largest pinnules to 7 mm long, bearing at base 1 or 2 pairs of 4th order leaflets which are round and entire, 1 mm long. *Sori* covered by overlapping fringed scales. *Scales and hairs*: lower surface of pinna-rachis densely scaly, some scales dark, shining, elongate with pale sparsely fringed or setiferous edges, some smaller, light brown and sub-bullate with setiform apex; near

base of costae dark shining ovate to elongate scales with pale edges bearing some dark setae, then light brown nearly flat roundish scales with short setiform apex to pale hair-tip; on costules a few scales which usually lack setae but may bear marginal hairs; small scales sometimes on lower surface of veins.

Type specimen: WOMERSLEY & MILLAR NGF 8470, Skindewai, 5400 ft, Morobe District, NE. New Guinea (K; dupl. at L, BO, A, SYD).

Distr. *Malaysia*: E. New Guinea (3 collections).

Ecol. At 1700–2400 m; “common through the rain-forest” (BRASS), in mixed *Nothofagus* forest (SCHODDE).

**146. *Cyathea auriculifera* COPEL. Philip. J. Sc. 6 (1911) Bot. 364; *ibid.* 77 (1947) 107.**

*Trunk* to 3 m; fronds 220 cm long, lower pinnae gradually reduced. *Stipe* 10 cm, copiously spiny (spines to 3 mm long), also densely covered with pale scales 10–55 mm long, larger ones twisted and rather straight, edges closely set with short dark setae; main *rachis* beneath rather closely spiny throughout, covered with a dark brown felt of very small mostly setiferous scales and at first with elongate pale scales attached to the thorns. *Pinnae*: lowest 11 cm long, largest 54 cm. *Pinnules* slightly overlapping, to 70 by 15 mm, fully pinnate, bases of tertiary leaflets 3 mm apart; *tertiary leaflets* mostly stalked, largest 9 by  $2\frac{1}{2}$  mm, several pairs near base of pinnule having 1 or 2 pairs of free quaternary leaflets, acroscopic basal tertiary leaflets deflexed across pinna-rachis; veins to 9 pairs, those in quaternary leaflets pinnately branched, rest mostly forked. *Sori* nearer to costules than to edge, covered with overlapping fringed scales until nearly ripe, fringe of these scales longer than on costal scales. *Scales and hairs*: pinna-rachis scaly beneath as main rachis; costae copiously scaly, larger scales 1 mm long, ovate-acute, dark and shining with pale edges bearing dark setae, smaller ones entirely pale, either with setae or fringing hairs, no bullate scales; costules and veins beneath bearing similar smaller scales; upper surface of costules glabrous.

Type specimen: C. KING 227, Goodenough Bay, 1200 m, Papua (MICH; fragm. at BM).

Distr. *Malaysia*: New Guinea and Louisiades.

Ecol. In mountain forest or transition to mossy forest, on mainland 1200–2600 m, on the islands 750–1000 m.

**147. *Cyathea teysmannii* COPEL. Philip. J. Sc. 4 (1909) Bot. 51 (new name for *C. celebica* v. A. v. R.); v. A. v. R. Handb. Suppl. (1917) 39.—*Hemitelia truncata* (non BRACK.) CHRIST, Ann. Jard. Bot. Btzig 15 (1898) 81; in Warburg, Monsunia (1900) 91.—*C. celebica* v. A. v. R. Bull. Dép. Agr. Ind. Néerl. 18 (1908) 2, non BL. 1828; Handb. (1908) 26.**

Differs from *C. tripinnata* in the presence of distinctly bullate pale scales on the costules, and in thinner and smaller soral scales which do not

cover the fully developed sporangia. The specimens do not give information about characters of the stipe and its scales, which may also be distinctive.

Type specimen: TEYSMANN 13681 (BO).

Distr. *Malaysia*: SW. Celebes.

Ecol. At c. 1000 m altitude.

**148. *Cyathea aciculosa*** COPEL. Philip. J. Sc. 60 (1936) 104, pl. 9.—*C. arachnoidea* (non HOOK.) GREYER & WAGNER, Un. Cal. Publ. Bot. 23 (1948) 43.

*Stipe* 18 cm long, dark, smooth, covered with minute scales, also near base with pale scales 25 by less than 1 mm, bearing dark marginal setae near apices. *Pinnæ*: lowest 10 cm long, largest 50 cm. *Pinnules* to 65 by 16 mm, fully pinnate; *tertiary leaflets* to 20 pairs, to 7 by almost 2 mm, larger ones crenate; veins 7 pairs. *Sori* covered with overlapping pale scales; no true indusium. *Scales and hairs*: pinna-rachis warty, shining, bearing many very small pale short-fringed scales and a few long narrow setiferous ones, these latter also on bases of costae; most scales on costae pale, bullate, also very small pale scales.

Type specimen: BRASS 2887, San Christoval, 900 m, Solomon Is (MICH; dupl. at L, BRI).

Distr. Solomon Is, in *Malaysia*: Admiralty Is.

Ecol. In forest, to c. 1000 m.

Note. This species is very near *C. truncata* BRACK.) COPEL. of Fiji and Samoa, differing in the much larger indusial scales.

**149. *Cyathea celebica*** BL. En. Pl. Jav. (1828) 245 (not v. A. v. R. 1908); TINDALE, Contr. N.S.W. Nat. Herb. 2 (1956) 338, p.p.—*Alsophila celebica* METT. Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 53; v. A. v. R. Handb. (1908) 42.—*C. arachnoidea* HOOK. Syn. Fil (1865) 24; v. A. v. R. Handb. (1908) 26; Suppl. (1917) 38.—*Alsophila truncata* var. *sagittata* CHRIST, Bull. Herb. Boiss. II, 1 (1901) 458.—*Alsophila truncata* var. *nivea* CHRIST, K. Sch. & LAUT. Nachtr. (1905) 36; v. A. v. R. Handb. (1908) 42.—*C. quadripinnatifida* COPEL. Un. Cal. Publ. Bot. 18 (1942) 218; Philip. J. Sc. 77 (1947) 108, pl. 6.

*Stipe* to 100 cm long, dark, bearing slender dark spines to 3 mm long, near base bearing persistent light brown scales 20–40 mm long, mostly not over 1 mm wide, firm and shining, edges bearing close short oblique concolorous setae, rest of stipe covered closely with small interlacing setiferous or fringed scales. *Pinnæ*: small pinnae (5–8 cm long) sometimes present near base of stipe (seen only in two specimens); largest pinnae to 70 cm long. *Pinnules* 90–140 by 17–28 mm, fully pinnate, the lower tertiary leaflets stalked; costules (stalks of tertiary leaflets) 3–5 mm apart; *tertiary leaflets* to 15 by 2½–5 mm, sometimes dilated at the base, the largest deeply lobed near the base, the basal lobes sometimes forming free quaternary leaflets. *Sori* medial, protected when young by overlapping very thin finely fringed scales. *Scales and hairs*: pinna-rachis and costae beneath almost covered with very small irregular pale scales bearing short

marginal hairs and some larger scales bearing setae; costules at first bearing small ovate scales bearing setae, lower surface of costules and veins covered throughout with small pale fringed scales which interlace and completely cover lower surface of lamina.

Type specimen: REINWARDT, Ternate (L; dupl. at BM).

Distr. Queensland, in *Malaysia*: New Guinea, Moluccas (Ternate, Ambon), ? Celebes.

Ecol. At 100–1750 m.

Note. The type of *C. quadripinnatifida* was in open forest in a ravine and had 4 fronds 600 cm long (including stipe of 100 cm); these do not show reduced basal pinnae.

**150. *Cyathea tripinnata*** COPEL. Philip. J. Sc. 1, Suppl. 4 (1906) Bot. 251; *ibid.* 4 (1909) Bot. 40; v. A. v. R. Handb. (1908) 788; Suppl. (1917) 39; HOLTUM, Rev. Fl. Mal. 2 (1954) 120; COPEL. Fern Fl. Philip. 1 (1960) 208.—*C. densisora* v. A. v. R. Bull. Jard. Bot. Btzg III, 2 (1920) 138; COPEL. Fern Fl. Philip. 2 (1960) 208.—*C. leucostegia* COPEL. Philip. J. Sc. 38 (1929) 130; Fern Fl. Philip. 2 (1960) 209.—*C. leytenensis* COPEL. Philip. J. Sc. 38 (1929) 131; Fern Fl. Philip. 2 (1960) 209.—*C. arachnoidea* (non HOOK.) BACKER & POSTH. Varenfl. Java (1939) 25.

*Trunk* to 4 or 5 m. *Stipe* to at least 40 cm, dark, bearing scattered sharp spines 1–3 mm long, covered almost throughout by a felt of very small setiferous scales; basal scales to 25 by 1 mm, thin and soft, matted together, edges with some dark setae, apex a dark seta. *Pinnæ*: lowest 20–30 cm long, largest to 60 cm. *Pinnules* 90–140 by 17–25 mm, fully pinnate, lower tertiary leaflets distinctly stalked; costules 4–6 mm apart; *tertiary leaflets* to 15 by 3½ mm, the larger ones deeply lobed at the base, edges crenate; veins to 9 pairs, those in basal lobes pinnate. *Sori* near costules, covered to maturity by overlapping pale thin scales. *Scales and hairs*: lower surface of pinna-rachis covered with minute pale fringed scales; costae bearing similar scales with some longer narrow ones bearing a fringe of hairs or dark setae; on costules ovate flat brown to pale scales, setiferous or fringed; on veins no scales.

Type specimen: COPELAND 2068, Mt Mariveles, in extinct crater, 900 m, Luzon (MICH; dupl. at US, P, UC, SYD, S-Pa).

Distr. *Malaysia*: West Java, Pulau Tioman (E off Malaya), N. Borneo, Philippines (Luzon to Mindanao), Moluccas (Ambon).

Ecol. In forest, 250–1700 m; the smaller forms, represented by *C. densisora*, *C. leytenensis* and *C. leucostegia* probably in more exposed places.

**151. *Cyathea macrophylla*** DOMIN, Acta Bot. Bohem. 9 (1930) 133 (new name for *Hemitelia ledermannii* BRAUSE); COPEL. Philip. J. Sc. 77 (1947) 108.—*Hemitelia ledermannii* BRAUSE, Bot. Jahrb. 56 (1920) 60.

Differs from *C. tripinnata* in firmer texture of lamina and in presence of more or less abundant small scales on lower surface of veins, these scales

bearing short dark setae or short pale hairs, never long-fringed nor covering lower surface of lamina.

Type specimen: LEDERMANN 12533, Sepik Region, E. New Guinea (B).

Distr. *Malaysia*: New Guinea.

Ecol. In forest, from sea-level to 1500 m.

var. **quadripinnata** HOLTUM, var. nov.

A typo species differt: stipitibus c. 10 cm longis;

*foliolis tertiariis maximis 18 mm longis, omnino profunde lobatis, segmentis infimis interdum liberis et stipitulatis.*

Type specimen: WOMERSLEY NGF 13959, Morobe Distr., NE. New Guinea (K).

Ecol. "Short tree-fern in under-storey of the forest. Trunk not more than 2 feet tall. Fronds 5 feet", 2000 m.

4. Section **Schizocaena**

(J. SM.) HOLTUM, stat. nov.—*Schizocaena* J. SM. in Hook. Gen. Fil. (1838) t. 2; Lond. J. Bot. 1 (1842) 661, p.p.; COPEL. Gen. Fil. (1947) 99, p.p.—Fig. 8c, 28-30.

Type species: *Schizocaena brunonis* J. SM. = *Cyathea moluccana* R. BR.

Distr. *Malaysia* and Polynesia.

Taxon. The division into two subsections is perhaps not sharp, but extreme examples of *subsect. Sarcopholis* are strikingly different from species of *subsect. Schizocaena* from Western *Malaysia*. The characteristic feature of the section is the position of the basal basicopic vein of each vein group; this vein springs from the costa, not from the costule (or in *C. moluccana* from the midrib of the pinna). This condition is correlated with the relatively shallow lobing of the pinnules; similar lobing in *subg. Cyathea sect. Gymnosphaera* is usually not associated with this vein-character.

The species *C. sinuata* HOOK. and *C. hookeri* THW., of Ceylon, included here by J. SMITH and COPELAND, have flabelloid scales; in my opinion their nearest relatives are in the group of *C. borbonica* DESV. of Madagascar.

4a. Subsection *Schizocaena*

Distr. *Malaysia*, except Moluccas and New Guinea.—Fig. 8c, 28-29.

Taxon. In Borneo and the Philippines species of this subsection are often difficult to characterize clearly, appearing to vary in size and in distribution of scales and hairs on axes.

KEY TO THE SPECIES

- 1. Fronds simply pinnate, pinnae entire or at most serrate-crenate.
- 2. Apex of frond a deltoid deeply lobed lamina. Outer veins of each group joining to form a single excurrent vein. Pinnae sessile, base truncate or subcordate . . . . . 152. *C. capitata*
- 2. Apex of frond a pinna of same shape as other pinnae. No anastomosis. Pinnae usually stalked.
- 3. Pinnae not over 15 mm wide, base narrowly cuneate, stalkes to 12 mm long. Sori in 1-2 rows on each side of costa, fully indusiate . . . . . 153. *C. angustipinna*
- 3. Pinnae 2-4 cm wide, base rather broadly cuneate, stalked or not. Sori in fully fertile fronds in more than 2 rows, indusiate or not.
- 4. Pinnae not long-acuminate, upper usually sessile . . . . . 154. *C. moluccana*
- 4. Pinnae long-acuminate, all stalked . . . . . 155. *C. arthropoda*
- 1. Fronds simply pinnate with deeply lobed pinnae, or bipinnate.
- 5. Fronds simply pinnate with deeply lobed pinnae, the largest sometimes with free pinnules at their base.
- 6. Lower surface of pinna-midribs covered near base with long hairs; no free pinnules. . . . . 156. *C. deminuens*
- 6. Lower surface of pinna-midrib lacking hairs; some free pinnules on largest pinnae.
- 7. Indusium present (sometimes hidden by mature sorus).
- 8. Lower pinnae little narrowed at base, free leaflets as long as lobes, apex not long-acuminate; pinnae commonly 25 cm long . . . . . 157. *C. alternans*
- 8. Lower pinnae narrowed to base so that free leaflets are very small, apex long-acuminate; pinnae to 18 cm long . . . . . 158. *C. binuagensis*
- 7. Indusium lacking.
- 9. Pinnae commonly 25 cm long; no long pale hairs on rachis . . . . . 157. *C. alternans*
- 9. Pinnae much shorter; main rachis bearing long pale hairs . . . . . 159. *C. elliptica*
- 5. Fronds amply bipinnate.
- 10. Pinnules entire or with crenate edges.
- 11. Indusia present; pinnules sessile . . . . . 157. *C. alternans*
- 11. Indusia lacking; pinnules stalked . . . . . 160. *C. obliqua*
- 10. Pinnules distinctly lobed.
- 12. Sori indusiate.
- 13. Pinnules of larger pinnae not lobed more than  $\frac{3}{4}$  to costa throughout, no free basal pinnules, or sometimes one on lowest pinnule of lower pinnae.



14. Bullate scales lacking on costules . . . . . 161. *C. integra*
14. Bullate scales present on costules.
15. Basal pinnules of middle pinnae with stalks to at least 4 mm long; pinnules lobed less than ½ way to costa . . . . . 162. *C. stipitipinnula*
15. Basal pinnules sessile or nearly so; pinnules lobed more than half way to costa.
16. Segments of pinnules acute, falcate; largest pinnules 20–30 mm wide. 163. *C. zamboangana*
16. Segments of pinnules rounded; largest pinnules not over 20 mm wide.
17. Indusium a disc hidden by sorus . . . . . 164. *C. discophora*
17. Indusium complete, breaking and persistent at maturity.
18. Lower surface of costae densely scaly . . . . . 165. *C. megalosora*
18. Lower surface of costae not densely scaly . . . . . 166. *C. suluensis*
13. Pinnules of larger pinnae always with one or more free basal segments.
19. Copious long hairs on lower surface of veins as well as costules.
20. About half the tertiary segments free or separately adnate to costa on largest pinnules. Pinnules to 100 by 20 mm. Costae not densely scaly . . . . . 167. *C. robinsonii*
20. One or two pairs tertiary segments free on largest pinnules. Pinnules to 80 by 12 mm. Costae densely scaly.
21. Costal scales not setiferous. Pinnules sessile . . . . . 165. *C. megalosora*
21. Costal scales strongly setiferous. Lower pinnules with stalks 2–3 mm long. 168. *C. senex*
19. No hairs on lower surface of veins.
22. Free basal segments of largest pinnules deeply lobed. Rachis and pinna-rachis densely persistently scaly, scales small, sub-bullate, setiferous . . . . . 169. *C. sibuyanensis*
22. Free basal segments entire. Rachises glabrescent .
23. Pinnules sessile, to c. 65 by 15 mm, often smaller . . . . . 170. *C. philippinensis*
23. Pinnules stalked (stalks to 8 mm), to 100 by 25 mm . . . . . 171. *C. assimilis*
12. Sori without indusia.
24. Long-spreading hairs abundant on lower surface of rachis and/or pinna-rachis, often also on costae.
25. Costules and veins bearing hairs like those of costae on lower surface.
26. Pinnules to 110 mm long, cut ⅔–¾ to costa; costules 5 mm apart . . 172. *C. trichodesma*
26. Pinnules to 65 mm long, cut to within 1 mm of costa; costules 3–3½ mm apart. 173. *C. wallacei*
25. Costules and veins lacking hairs on lower surface.
27. Hairs of lower surface confined, or almost confined, to main rachis . . 159. *C. elliptica*
27. Hairs of lower surface present on pinna-rachis and costae, few or none on main rachis. 174. *C. trichophora*
24. Long spreading hairs lacking on lower surface of rachis and pinna-rachis.
28. Largest pinnules with a free segment at the base; pinnules on stalks to 4 mm or more long; texture firm . . . . . 175. *C. polyopoda*
28. Largest pinnules lacking a free segment at the base, almost sessile.
29. Sori on 3–4 pairs of basal veins in each group only, not on distal veins, at maturity confluent. 176. *C. obscura*
29. Sori on almost all veins, not confluent at maturity.
30. Bullate scales lacking on costae and costules. Pinnules cut to less than 1 mm from costa; stout erect hairs abundant on upper surface of costules and veins . . 177. *C. agatheti*
30. Bullate scales present on costae and costules. Pinnules less deeply lobed; hairs on upper surface of costules few . . . . . 178. *C. squamulata*

152. *Cyathea capitata* COPEL. Philip. J. Sc. 12 (1917) Bot. 49; C. CHR. & HOLTUM, Gard. Bull. S. S. 7 (1934) 199, 218.—*Schizocaena capitata* COPEL. Gen. Fil. (1947) 99.—Fig. 28f–h.

*Trunk* 1–3 m, bearing c. 12 fronds. *Stipe* dark, smooth, at least 40 cm; basal scales pale brown, firm, to 25 by 3–4 mm, rather thick at the base, edges bearing rather irregular concolorous setae; *pneumathodes* 9–15 mm long, rather widely spaced. *Rachis* dark to medium brown, smooth; *lamina* 100 cm or more long, simply pinnate, apex of frond not like a pinna but broadly deltoid and deeply lobed, lobes grading to upper pinnae. *Pinnae* c. 40 pairs, sessile, jointed to rachis, largest 15–19 by 2–3 cm wide at base, lower ones somewhat smaller, edges entire except near apex, base

truncate to cordate, in the latter case more or less auricled on both sides, apex short-acuminate, crenate. *Veins* pinnate in each group, usually with 3 pairs of veinlets, outer veinlets of each group always anastomosing with outer veinlets of adjacent groups to form a single excurrent vein; basal basiscopic vein of each group springing separately from the costa. *Sori* usually in 2 rows on each side of the costa (3–4 sori on each vein-group) or in narrower pinnae only one row; indusium thin and translucent, at first covering sorus, later breaking irregularly and more or less persistent.

Type specimen: CLEMENS 11033, Mt Kinabalu, N. Borneo (MICH; dupl. at A, UC, K).

Distr. *Malaysia*: Borneo (Sarawak: Mt



Murud; N. Borneo: Mt Kinabalu).

Ecol. Near a waterfall and in wet ground near a stream, in forest, 1400–2100 m.

**153. *Cyathea angustipinna* HOLTUM**, Kew Bull. 16 (1962) 52.

*Stipe* 30 cm, smooth, scaly near base, scales pale, firm and shining, to c. 20 by  $1\frac{1}{2}$  mm, edges bearing copious short dark setae. *Frond* 70 cm long, simply pinnate; pinnae about 18 pairs, jointed to rachis; terminal pinna like the rest, usually with a small rudiment beside it. *Pinnae* stalked to 12 mm or more (lowest longest), to 12 cm long, fertile ones 1–1.2 cm wide, sterile to 1.6 cm, bases narrowly cuneate (of lower ones somewhat asymmetric) apices shortly acuminate, edges entire except towards apices where they are crenate; *veins* commonly in groups of three, middle one sometimes forked, basiscopic one separately attached to costa. *Sori* 2 or 3 on each vein-group (middle vein not always soriferous), in two rather uneven rows on each side of the costa; indusium thin and pale, covering young sorus and breaking later, more or less persistent as a disc around base of old sorus; *costae* usually quite glabrous on both surfaces.

Type specimen: RICHARDS 1675, Mt Dulit, 1200 m, Sarawak (K).

Distr. *Malaysia*: Borneo (Sarawak, two collections).

Ecol. Sandy bank of a stream, near waterfall, in shade; trunk 50 cm.

**154. *Cyathea moluccana* R. Br.** in Desv. Mém. Soc. Linn. Paris 6 (1827) 322; v. A. v. R. Handb. (1908) 15; COPEL. Philip. J. Sc. 4 (1909) Bot. 32; v. A. v. R. Bull. Jard. Bot. Btzig II, n. 28 (1918) 12.—*Schizocaena brunonis* J. Sm. ex HOOK. Gen. Fil. (1838) t. 2; J. Sm. Hist. Fil. (1875) 243.—*C. brunonis* WALL. ex HOOK. Sp. Fil. 1 (1844) 15; Syn. Fil. (1865) 16; BEDD. Ferns Br. Ind. (1865) pl. 87; Handb. (1883) 5; CHRIST, Farnkr. Erde (1897) 318; DIELS in E. & P. Pfl. Fam. 1, 4 (1899) 127; COPEL. Sarawak Mus. J. 2 (1917) 345, 347; HOLTUM, Rev. Fl. Mal. 2 (1954) 117.—*C. pinnata* ROXB. Calc. J. Nat. Hist. 4 (1844) 517; Fl. Ind. ed. Clarke (1874) 762.—*Schizocaena gaudichaudii* FÉE, Gen. Fil. (1852) 354.—*C. pseudobrunonis* COPEL. Philip. J. Sc. 12 (1917) Bot. 50.—*C. fuscopaleata* COPEL. l.c. 50.—*C. kinabaluensis* COPEL. l.c. 51; C. CHR. Gard. Bull. S.S. 7 (1934) 218.—*Schizocaena moluccana* COPEL. Gen. Fil. (1947) 99.—*Schizocaena kinabaluensis* COPEL. l.c. 99.—**Fig. 28a–e.**

*Trunk* usually not over 50 cm tall. *Stipe* commonly 20–30 cm, dark, scaly near base and finely warty when scales have fallen; scales medium brown, firm, 15–30 by  $\frac{1}{2}$ –3 mm, edges bearing setae little darker than scale. *Lamina* to 150 cm or more long (largest frond reported, stipe with lamina 308 cm), simply pinnate, apical pinna usually like the rest (sometimes with a rudiment at its base), all pinnae articulate to rachis. *Pinnae* stalked or the upper ones sessile (stalks variable in length, the lowest 5–10 mm), 12–28 by 2–4 cm, edges parallel for most of their length, base asym-

metric (rounded on acroscopic side, broadly cuneate on basiscopic), apex shortly acuminate and crenate, edges otherwise entire, rarely slightly lobed with one lobe to each vein-group; *veins* in groups of 3 from the costa (basiscopic one usually separate from the other two), the median one forked once or twice to give a group of 3–6 (rarely to 10) veins at the edge, veins all free and all ending close to the margin, or sometimes the acroscopic vein ending in a sorus or joining with another vein. *Sori* in 1–3 (rarely more) rows on each side of the midrib, commonly 4–6 on each vein-group, exceptionally to 10 (in such cases the edge usually lobed), covered when young by a thin translucent indusium which breaks at maturity and is more or less persistent, or in some cases the indusium forming a disc which is hidden by the mature sporangia; lower surfaces of rachis, costae and veins usually glabrous, occasionally a few persistent small ciliate or setiferous scales present.

Type specimen: C. SMITH, Moluccas (BM).

Distr. *Malaysia*: Central Sumatra, Malay Peninsula, Lingga, Borneo (excluding south and south-west), South & Central (?) Celebes, Moluccas (Ceram, Ambon).

Ecol. In forests, 0–900 m.

Notes. Fronds bearing imperfect indusia appear to be most common in Borneo, but occur also in the Malay Peninsula. COPELAND described the three species *C. pseudobrunonis*, *C. fuscopaleata* and *C. kinabaluensis* as lacking indusia, but I have not found a specimen totally devoid of indusia, though in old specimens only small fragments remain (VAN ALDERWERELT made the same observation, 1918 l.c.). COPELAND thought that species could also be distinguished by size and colour of stipe-scales, but, after seeing a very large number of specimens, I cannot see any clear distinction into groups based on such characters. COPELAND's fourth species, *C. arthropoda*, is here regarded as distinct in shape of pinnae.

R. BROWN described this species, but did not name it, in 1810 (Prod. Fl. N. Holl. 158); DESVAUX supplied a name, copying the information provided by BROWN. The type must be the specimen seen from the Moluccas by BROWN, though it is not named by him.

**155. *Cyathea arthropoda* COPEL.** Philip. J. Sc. 6 (1911) Bot. 134, t. 13; v. A. v. R. Handb. Suppl. (1917) 22.—*Schizocaena arthropoda* COPEL. Gen. Fil. (1947) 99.

*Fronds* simply pinnate; lamina to c. 70 cm long, apical pinna like the rest. *Pinnae* jointed to rachis, always stalked (stalks of upper pinnae c. 5 mm, of lower ones 12–15 mm), 12–20 cm long, fertile to  $2\frac{1}{2}$  cm wide, sterile to  $3\frac{1}{2}$  cm, base almost equally cuneate, apex caudate-acuminate (cauda to 4 cm long), sides for the most part not parallel. *Sori* in 1–3 irregular rows on each side of the costa; indusium a narrow irregular ring, hidden by sporangia, or lacking.

Type specimen: BROOKS 8, Bungo Range, Sarawak (MICH; dupl. at BM).

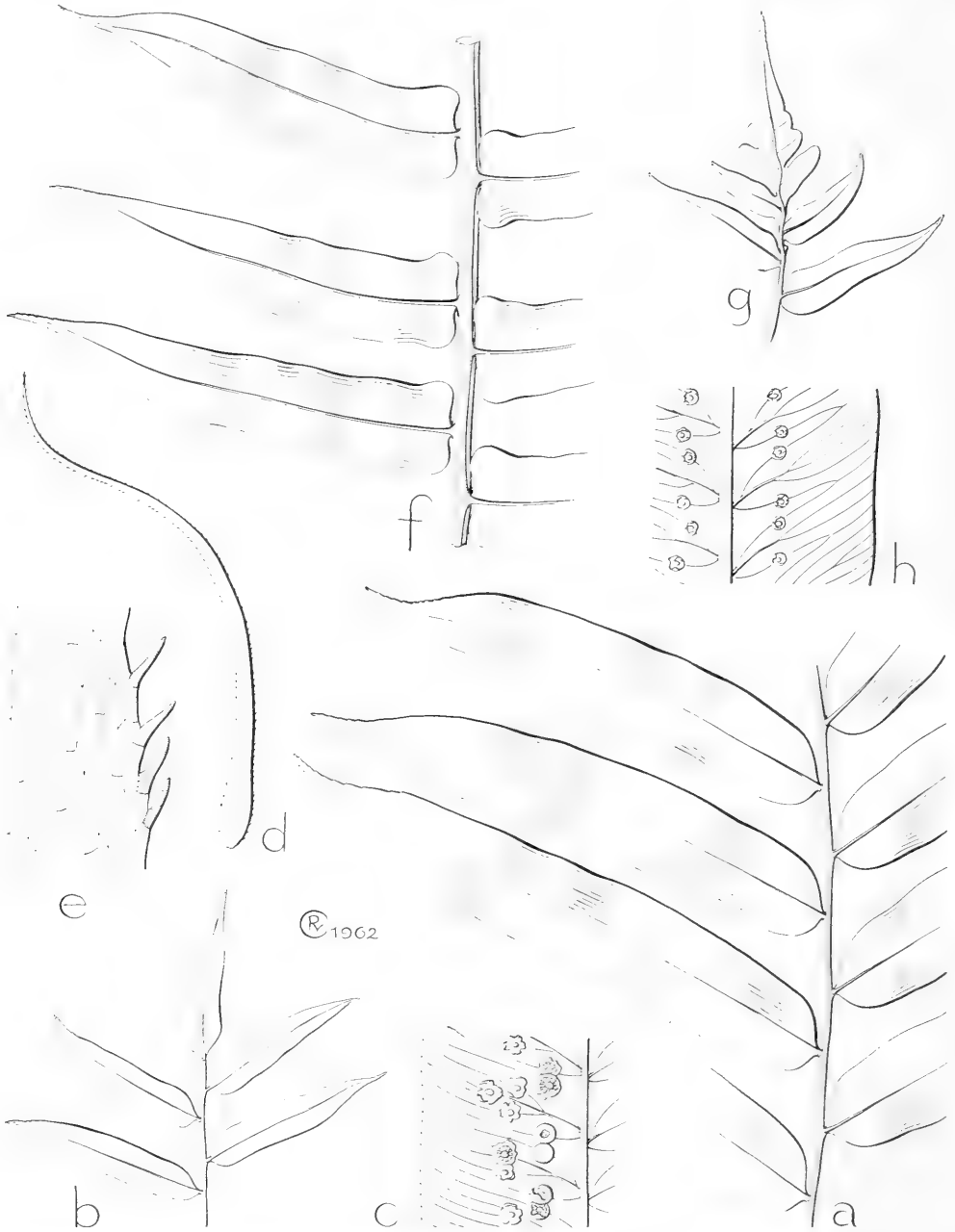


Fig. 28. *Cyathea moluccana* R. Br. *a.* Middle part of rachis with pinnae,  $\times \frac{1}{2}$ , *b.* apex of frond,  $\times \frac{1}{2}$ , *c.* part of pinna, showing venation and sori,  $\times 1\frac{1}{2}$ , *d.* scale from stipe,  $\times 4$ , *e.* edge of stipe-scale,  $\times 40$ . — *C. capitata* COPEL. *f.* Middle part of rachis with pinnae,  $\times \frac{1}{2}$ , *g.* apex of frond,  $\times \frac{1}{2}$ , *h.* part of pinna showing venation and sori,  $\times 1\frac{1}{2}$  (*a–e* CUMING 378, *f* CLEMENS 27959, *g* JACOBS 5790, *h* CLEMENS 11033).

Distr. *Malaysia*: Sarawak (neighbourhood of Kuching).

Ecol. In lowland forest.

Note. This seems to be the most distinct of the "exindusiate" species described by COPELAND from Sarawak (see *C. moluccana*). Field study is necessary to decide whether or not it is connected by intermediate with typical *C. moluccana*, which occurs in the same district.

**156. *Cyathea deminuens* HOLTUM, nom. nov.**—*Alsophila parvifolia* HOLTUM, J. Mal. Br. R. As. Soc. 6 (1928) 19.

*Trunk* to 75 cm. *Stipe* to 15 cm; scales at base pale brown, rather firm, 10–15 mm by 1½ mm, edges closely set with dark setae. *Lamina* to 65 cm long, simply pinnate, pinnae pinnatifid, lower ones gradually reduced, lowest 3½ cm long. *Rachis* densely covered beneath throughout with stout pale spreading hairs to 3 mm long. Largest *pinnae* 9 by 2 cm, lobed ⅔ towards the costa; costules 5 mm apart; veins 6–7 pairs, basal basisopic vein from costa; lower surface of costae hairy towards base, and a few hairs on lower costules, no bullate scales seen; a few long hairs present on upper surface of costules and veins. *Sori* at about one third distance from costule to edge; no indusia; long paraphyses, with dark walls between the cells, present.

Type specimen: BODEN KLOSS 14579, Siberut, Mentawai Is (S; dupl. at BO; K).

Distr. *Malaysia*: Sumatra (two collections, the second from S. Sumatra).

Ecol. In lowland forest.

**157. *Cyathea alternans* (WALL. ex HOOK.) PRESL**, Abh. K. Böhm. Ges. Wiss. V, 5 (1848) 347; BEDD. Handb. Suppl. (1892) 2; v. A. v. R. Handb. (1908) 17; RIDL. J. Mal. Br. R. As. Soc. 4 (1926) 5, incl. var. *serrata* RIDL.; DOMIN, Acta Bot. Bohem. 9 (1930) 90, incl. var. *sarawakensis* (HOOK.) DOMIN and var. *lobbiana* (HOOK.) DOMIN; HOLTUM Rev. Fl. Mal. 2 (1954) 119.—*Polypodium alternans* WALL. Cat. (1829) n. 329, nom. nud.—*Hemitelia alternans* HOOK. Ic. Pl. (1844) t. 622; Sp. Fil. 1 (1844) 29.—*Amphicosmia alternans* MOORE, Ind. Fil. (1857) civ; BEDD. Handb. (1883) 10.—*C. lobbiana* HOOK. Syn. Fil. (1865) 24.—*C. sarawakensis* HOOK. l.c. 23; HOSE, J. Str. Br. R. As. Soc. 32 (1899) 35.—*Alsophila alternans* HOOK. Syn. Fil. (1866) 41; BEDD. Ferns Br. Ind. (1867) t. 236.—*Schizocaena alternans* J. Sm. Hist. Fil. (1875) 244; COPEL. Gen. Fil. (1947) 99.—*Alsophila janseniana* v. A. v. R. Bull. Jard. Bot. Btzg III, 5 (1922) 179.—*C. janseniana* DOMIN, Acta Bot. Bohem. 9 (1930) 126.

*Trunk* usually less than 2 m. *Stipe* to 60 cm, dark, persistently scaly near base, otherwise glabrescent and smooth; scales medium brown, firm, shining, to 30 by 2 mm, edges closely setiferous. *Pinnae* articulate to rachis, lowest somewhat reduced, largest commonly 25 by 4–5 cm, sometimes to 40 by 9 cm (in type of *C. sarawakensis* 50 by 16 cm), deeply lobed throughout or with few to many of the lobes separately joined by the more or less contracted base of their lamina to the

axis of the pinna, rarely the lowest one or two forming true pinnules with lamina quite free; costules of lobed pinnae 7–9 mm apart, of pinnae in which the lobes are free up to 15 mm apart; lobes which are not free usually entire and rounded at apex, free lobes acute at the apex or with margins sometimes broadly crenate, one crenation to each vein-group. *Veins* in the narrower, lobed, pinnae to c. 10 pairs in each lobe, individual veins forked once or twice; in free lobes the veins in small lateral pinnate groups. *Sori* usually in one row on each side of the costule of a lobe of a pinna, in the largest free lobes occasionally an incomplete second row; indusium varying greatly, in a minority of cases completely covering the young sorus and persistent, in most cases forming a disc of irregular width covered by the mature sorus, sometimes only detectable as small fragments; long pale paraphyses present. *Scales* on lower surface of pinna-midribs, costules and veins usually rather sparse, elongate, narrow and strongly setiferous, pale to medium brown, in some cases also bullate scales on costules; in some cases stout pale hairs present on distal parts of costae and costules and a few on veins.

Type specimen: WALLICH 329, Penang (K).

Distr. *Malaysia*: Sumatra (Karo plateau, Benkulen Distr.), Malay Peninsula (Penang, Perak, Negri Sembilan, Pahang, Trengganu, Kelantan), Sarawak and North Borneo.

Ecol. In forest, often near streams, at 300–1300 m.

Note. This species is usually found growing in association with *C. moluccana* R. Br. and always within the range of *C. moluccana*. The variable *C. alternans* has the appearance of being a series of hybrids between *C. moluccana* and either *C. squamulata* or *C. ridleyi* (which are bipinnate and exindusiate) with many possible combinations of characters of pinna-shape and of indusia and scales and hairs. The type specimen of *C. alternans* has pinnae to about 6½ cm wide, with 3 pairs of free adnate lobes, a few lobes longer than adjacent ones, as in the type of *Alsophila janseniana* v. A. v. R.; the sori have disc-shaped indusia, as shown in HOOKER, Ic. Pl. t. 622, though HOOKER stated later (Syn. Fil. 41) that "a depression formed by the sorus on the lobe was mistaken by the artist for an involucre". Hairs occur on the lower surface of costules in some Peninsular specimens (especially MOH. NUR 11269); I have not seen any on Bornean ones. Bullate scales appear more common in Peninsular than in Bornean specimens.

**158. *Cyathea binuangensis* v. A. v. R. Bull.** Jard. Bot. Btzg III, 2 (1920) 136; COPEL. Fern Fl. Philip. 2 (1960) 206.

*Stipe* 20 cm, densely scaly at base only; scales pale, thin, to 20 by 2 mm, edges bearing concolorous hairs. *Lamina* 50 cm long, simply pinnate. *Pinnae*: lowest slightly reduced; largest 18 by 4 cm, lobed to 3–4 mm from costa except at base where one segment is usually almost free; bases of pinnae conspicuously narrowed (free segment always smaller than rest), apex rather long-acuminate; lobes falcate, almost entire, their costules

to 9 mm apart; veins to about 10 pairs, mostly forked. *Sori* medial; indusium thin, breaking and persistent; paraphyses very dark. *Scales* on costae of pinnae very few, very narrow, pale, bearing sparse short concolorous hairs; no hairs seen on lower surface of pinnae, on upper surface present only near base of costae.

Type specimen: RAMOS & EDAÑO, BS 28779, Mt Binuang, Luzon (BO; dupl. at US, MICH, K).

Distr. *Malaysia*: Philippines (Luzon, one collection).

Note. This specimen has the aspect of a prematurely fertile plant of *C. integra* J. SM. ex HOOK., but it lacks the characteristic scales of that species. It has the same degree of division of the frond as *C. alternans* (WALL.) PRESL, but is very different in shape of pinnae, and in paraphyses. It might be a hybrid of *C. integra*, but I cannot suggest what other parent is likely.

**159. *Cyathea elliptica* COPEL.** Philip. J. Sc. 12 (1917) Bot. 51.—*C. subbipinnata* COPEL. *ibid.* 56 (1935) 471, pl. 1.—*C. holttumii* COPEL. *l.c.* 472, pl. 2.—*Gymnosphaera subbipinnata* COPEL. Gen. Fil. (1947) 99.—*Gymnosphaera holttumii* COPEL. *l.c.* 99.

*Stipe* scaly throughout, also bearing on abaxial surface some long spreading hairs, the latter sometimes very abundant and to 10 mm long; scales medium to light brown, shining, edges setiferous; main *rachis* similarly scaly and hairy, scales sometimes deciduous. *Pinnae*: lower ones not greatly reduced, largest 30–45 cm long. Largest *pinnules* 4.5–6.5 cm long, 10–14 mm wide, sessile, lobed half way to costa; costules  $3\frac{1}{2}$ –4 mm apart; veins to 5 pairs; lamina-segments rather thin, entire, ends rounded. *Sori* medial; no indusia; paraphyses not longer than sporangia. *Scales and hairs*: lower surface of pinna-rachis lacking hairs or a few present near the base; costae bearing sparse narrow pale scales and sometimes a few hairs; costules bearing pale hair-pointed bullate scales.

Type specimen: CLEMENS 10859, Mt Kinabalu, N. Borneo, (MICH; dupl. at UC).

Distr. *Malaysia*: North Borneo.

Ecol. In forest, 900–1800 m.

Note. The type-collection of *C. holttumii* has much more abundant hairs on all parts of the frond than the other specimens referred to this species. The type of *C. subbipinnata* was collected at 1800 m, and is small, with largest pinnae only 10 cm long, having only one or two pairs of small free pinnules; the specimen is old and has lost most of its scales and hairs. It seems doubtful whether *C. elliptica* should be maintained as distinct from 174. *C. trichophora* COPEL.

**160. *Cyathea obliqua* COPEL.** in Elmer, Leaf. Philip. Bot. 4 (1911) 1150.—*Alsophila obliqua* C. CHR. Ind. Fil. Suppl. 1 (1913) 5; v. A. v. R. Handb. Suppl. (1917) 54.—*Gymnosphaera obliqua* COPEL. Gen. Fil. (1947) 98; Fern Fl. Philip. 2 (1960) 236.

*Stipe* unknown. *Pinnae* to 30 cm long. *Pinnules* to 72 by 10 mm, the lowest on stalks to 5 mm long,

articulate to rachis, base very unequally cuneate (narrow on basiscopic side), apex caudate-acuminate, edges broadly crenate, lamina rather thin; veins in pinnate groups each with up to 4 pairs, lowest basiscopic vein of each group springing from the costa. *Sori* 1–3 on each vein-group; no indusia; paraphyses as long as sporangia. *Scales and hairs*: pinna-rachis glabrous on lower surface; costal scales rather sparse, flat and ovate-acute to bullate and acuminate, light brown, most with a short fringe of pale hairs, some bearing dark setae.

Type specimen: ELMER 12354, Sibuyan I., Philippines (MICH; dupl. at K, A, BO, US, FI, S-PA, SYD, L).

Distr. *Malaysia*: Philippines (Sibuyan I., once collected), at 600 m.

**161. *Cyathea integra* J. SM. ex HOOK.** Ic. Pl. (1844) t. 638, incl. also var. *petiolata* HOOK. *l.c.* t. 638, fig. 2; Sp. Fil. 1 (1844) 26; Syn. Fil. (1865) 23; v. A. v. R. Handb. (1908) 20 (not Suppl. 25, which is *C. urdanetensis* COPEL.); COPEL. Philip. J. Sc. 4 (1909) Bot. 35; Fern Fl. Philip. 2 (1960) 200.—*Trichopteris falcata* LLANOS, Fragm. Pl. Filip. (1851) 111 (*fide* MERRILL, Sp. Blanc. 1918, 41).—*C. hypocrateriformis* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 7 (1912) 9; Handb. Suppl. (1917) 39; COPEL. in Elmer, Leaf. Philip. Bot. 5 (1913) 1680.—*C. bulusanensis* COPEL. in Elmer, Leaf. Philip. Bot. 9 (1920) 3109; Fern Fl. Philip. 2 (1960) 201.—*C. arguta* COPEL. Philip. J. Sc. 38 (1929) 133; Fern Fl. Philip. 2 (1960) 203.—*C. breviloba* COPEL. Philip. J. Sc. 81 (1952) 13; Fern Fl. Philip. 2 (1960) 201.—Fig. 29a, b.

*Stipe* 20–40 cm, base with spines 2 mm long; scales at base of stipe thin, pale, edges closely setiferous, to 25 by  $1\frac{1}{2}$  mm; also above base a more or less persistent cover of very small pale fringed or setiferous scales. Main *rachis* medium brown when dry, in basal part bearing scattered short spines, otherwise smooth and glabrescent. *Pinnae*: lowest c. 15 cm long, largest 60 cm. *Pinnules* on larger pinnae 80–120 by 15–25 mm, sessile or lowest stalked to 2 mm (rarely to 4 mm), apex acuminate (not caudate), in lowest pinnules on lower pinnae the basal segment sometimes just free, otherwise whole pinnule lobed to 2–3 mm from costa; costules 6 mm apart; veins 6–8 pairs; lamina-segments firm, edges almost entire or distinctly crenate towards apices, apex bluntly to acutely pointed at end of falcate costule. *Sori* medial; indusium at first complete, thin and translucent but firm, breaking and persisting at maturity; paraphyses abundant, as long as sporangia, pale. *Scales and hairs*: pinna-rachis beneath glabrescent, smooth or sparsely warty, residual scales small, pale, fringed or some with setae; on costae near base narrow pale scales with dark marginal setae, smaller ones with irregular fringe of pale hairs; on costules scales like smaller ones on costae, not bullate; stout spreading hairs rarely present on lower surface of costae and costules near apex of pinnule, not on upper surface of costules.

Type specimen: CUMING 120, Luzon (K; dupl. at US).

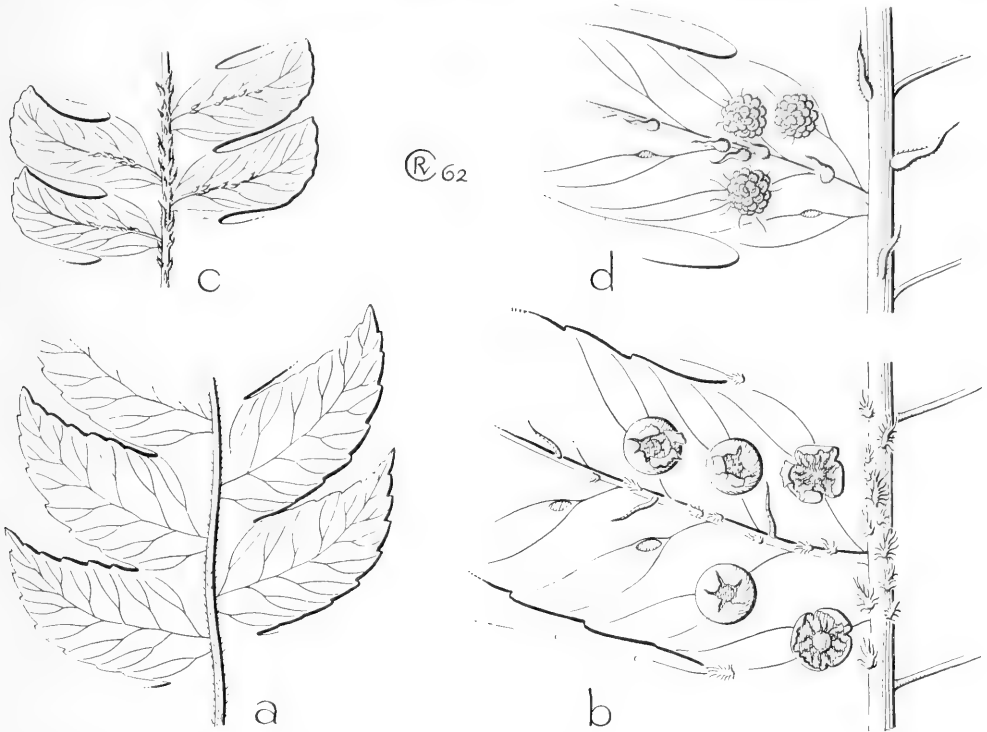


Fig. 29. *Cyathea integra* J. SM. *a.* Part of pinnule, upper surface,  $\times 2$ , *b.* lower surface showing scales and sori,  $\times 6$ .—*C. squamulata* (BL.) COPEL. *c.* Part of sterile pinnule, lower surface,  $\times 2$ , *d.* part of fertile pinnule showing sori and scales,  $\times 6$  (*a-b* SINCLAIR 9539, *c* SINCLAIR 10336, *d* KIAH 32179).

Distr. *Malaysia*: Philippines (Luzon, Mindoro, Panay, Samar, Catanduanes, Basilan, Biliran, Mindanao).

Ecol. In forest at low and medium altitudes; range reported 500–1200 m, but few specimens bear relevant information.

Notes. With the original description of this species, HOOKER cited first a specimen from Ambon, then CUMING 120 from Luzon; his figure was certainly prepared from the Luzon specimen, which I therefore regard as the type. The Ambon specimen is quite distinct in shape of lamina-segments and details of scales; it belongs to *C. tripinnatifida* ROXB.

There is considerable variation in size, shape and marginal teeth of the segments of the pinnules in *C. integra*; there is also variation in the presence of hairs on the lower surface of costae and in length of stalks of lower pinnules. I have not observed clear correlation of such characters, and do not think that *var. petiolata* Hook. can be regarded as a distinct variety.

**162. *Cyathea stipitipinnula* HOLTUM**, Kew Bull. 16 (1962) 62.

*Stipe* to more than 30 cm, medium dull brown, rather persistently scaly, warty where scales have

fallen; larger scales to 25 by 3 mm, shining brown with paler edges bearing many dark setae, also minute pale irregularly fringed scales; main *rachis* smooth, glabrescent. *Pinnae* to 45 cm long. *Pinnules* almost at right angles to rachis, to 65 by 12 mm, lobed less than half way to costa, lobes rounded and entire, texture coriaceous, the lowest pinnules with cordate bases and on stalks to 4 mm long; costules  $3\frac{1}{2}$ –4 mm apart; veins 3–4 pairs, thick. *Sori* usually 3 to each lobe, medial; indusia pale, firm, complete, breaking irregularly and persistent; paraphyses dark. *Scales and hairs*: scales near base of costae ovate-acute, flat, light brown, with numerous crisped marginal hairs or the larger with some setae, grading to light brown bullate scales (often fringed near apices) on costules and on veins.

Type specimen: CLEMENS 33156, Mt Kinabalu, N. Borneo (K; dupl. at BO, A, UC, L).

Distr. *Malaysia*: N. Borneo (Mt Kinabalu, several collections).

Ecol. In open places in forest, 1200–1500 m.

**163. *Cyathea zamboangana* COPEL.** Philip. J. Sc. 30 (1926) 325; Fern Fl. Philip. 2 (1960) 201.—*C. urdanetensis* COPEL. Philip. J. Sc. 38 (1929) 132; Fern Fl. Philip. 2 (1960) 203.—*C. integra* (non

J. SM. *ex* Hook.) v. A. v. R. Handb. Suppl. (1917) 25.

*Trunk*: leaf-scars elliptic,  $2\frac{1}{2}$  cm wide, in alternate whorls of 3. *Stipe* 30 cm, base spiny (spines slender, dark, abundant, 1–3 mm) and densely covered with scales; scales to c. 10 by 1 mm, mostly smaller, edges with close dark setae. Main *rachis* spiny, pale, glabrescent. *Pinnae*: lowest somewhat reduced, largest to 60 cm or more long. *Pinnules* on larger pinnae 100–130 by 25–35 mm, lower ones on stalks 3–4 mm long, one lowest segment sometimes just free, rest of pinnule lobed to about  $2\frac{1}{2}$  mm from costa; costules 6 mm apart; veins to 8 pairs, mostly forked, a few with acroscopic branch again forked; lamina-segments thin but firm, apices falcate, acute, edge sometimes serrate near apex. *Sori* almost medial; indusium complete, globose, breaking and persistent at maturity. *Scales and hairs*: pinna-rachis pale, smooth, with some residual narrow pale setiferous scales; on costae scattered very small pale short-fringed scales and near base a few narrow pale setiferous scales, sometimes a few stout pale hairs near apex of pinnule; on costules pale bullate scales, sometimes with setae near apex, also sometimes stout pale hairs near apices of segments; upper surface of costules lacking hairs.

Type specimen: COPELAND 1646, near San Ramon, Mindanao (MICH).

Distr. *Malaysia*: (Mindanao).

Ecol. In forest, 500–800 m.

**164. *Cyathea discophora* HOLTUM**, Kew Bull. 16 (1962) 54.

*Stipe* finely warty throughout, persistently scaly near base; scales pale, to 25 by 2 mm, edges closely set with short dark setae; *rachis* light brown, glabrescent, sparsely and finely warty. *Pinnae* to 50 cm long, pinnules rather widely spaced. *Pinnules* sessile, to 8 by  $1\frac{1}{2}$  cm, lobed  $\frac{2}{3}$  towards the costa except at the very base, lowest segment not free; costules 4– $4\frac{1}{2}$  mm apart; lamina-segments rather thin, edges crenulate, apex broad, sinuses narrow; veins 6–7 pairs. *Sori* medial; indusium at length a thin brown disc of irregular shape, sometimes excentric, completely covered by mature sorus; paraphyses dark, a little longer than sporangia. *Scales and hairs*: pinna-rachis glabrescent beneath; costae rather densely scaly, scales at base pale, flat, elongate with short rather stiff pale marginal hairs, grading through similar scales bullate at base to rather large pale bullate scales with or without marginal hairs near their acuminate apices; a few long pale hairs on costa near apex of pinnule; costules bearing large pale bullate acuminate scales and few hairs; upper surface of costules glabrous.

Type specimen: CLEMENS 31698, Mt Kinabalu, N. Borneo (B; dupl. at US, BO).

Distr. *Malaysia*: N. Borneo (Mt Kinabalu, once collected).

Ecol. In open place in forest, 2400 m.

Note. This occurs within the altitudinal range

of *C. megalosora* COPEL., and is intermediate in soral characters between *C. megalosora* and the exindusiate *C. squamulata* (BL.) COPEL. which occurs at lower altitudes.

**165. *Cyathea megalosora* COPEL.** Philip. J. Sc. 12 (1917) Bot. 54; C. CHR. Gard. Bull. S.S. 7 (1934) 221.

*Trunk* to at least 2 m. *Stipe* c. 30 cm, pale to medium brown when dry, densely scaly, finely warty where scales have fallen; scales thin, pale, somewhat crisped, to c. 25 by  $1\frac{1}{2}$  mm, edges bearing rather sparse dark setae towards apex. *Pinnae*: lowest 20 cm long, largest 35 cm. *Pinnules* to 60 by 12 mm, almost sessile; lowest 1–2 segments free, rest of pinnule lobed nearly to costa; costules 4–5 mm apart; veins 5–7 pairs; lamina-segments very firm, edges crenate, apices rounded, sinuses narrow. *Sori* medial; indusium firm, brown-translucent, quite covering sorus to maturity, breaking irregularly and persistent; paraphyses as long as sporangia. *Scales and hairs*: pinna-rachis persistently densely scaly on lower surface, scales long, pale, entire or nearly so, bases of smaller ones bullate; costae densely scaly on lower surface, scales elongate, pale, almost entire, not setiferous, on distal part of costae many long spreading hairs; costules bearing similar hairs, and scattered hairs on veins also; upper surface of costules and veins bearing long pale hairs.

Type specimen: TOPPING 1759, Mt Kinabalu, N. Borneo (US; dupl. at A, K, SING, S-PA).

Distr. *Malaysia*: N. Borneo (Mt Kinabalu).

Ecol. In mossy forest on ridges, 2200–2900 m. At the highest altitudes the lamina of fronds may be only 40 cm long, pinnae to  $10\frac{1}{2}$  by  $2\frac{1}{2}$  cm, with about 5 pairs of free pinnules which are lobed half-way to the costa.

**166. *Cyathea suluensis* BAK.** J. Bot. 17 (1879) 65; v. A. v. R. Handb. (1908) 18; COPEL. Philip. J. Sc. 4 (1909) Bot. 35; Fern Fl. Philip. 2 (1960) 202. —*C. sessilipinnula* COPEL. Philip. J. Sc. 38 (1929) 134; Fern Fl. Philip. 2 (1960) 202.

*Stipe* to more than 30 cm, minutely spiny to the base; no scales seen. *Pinnae*: lowest about 10 cm long, largest 30 cm. *Pinnules* on larger pinnae 50–70 by 13–18 mm, sessile, short-acuminate, lobed  $\frac{1}{2}$ – $\frac{3}{4}$  towards the costa, no free basal segments; costules 4–5 mm apart; veins 4–7 pairs, strongly oblique; lamina-segments thin, slightly crenate near rounded apices, sinuses narrow. *Sori* medial; indusium complete, thin, pale, breaking irregularly and persistent. *Scales and hairs*: pinna-rachis beneath glabrescent, residual scales small, pale, short-fringed; on costae near base narrow flat pale dark-setiferous scales, throughout brown bullate scales, often with setae near apex, distally some stout pale hairs; on costules bullate scales, pale brown, and a few hairs; no hairs on upper surface of costules.

Type specimen: BURBIDGE *s.n.*, 1877–78, Sulu Is (K).

Distr. *Malaysia*: Philippines (Mindanao, Basilan, Sulu Is), Moluccas (Ternate ?).

Ecol. At c. 600 m.

Note. Specimens from Ternate placed tentatively in this species are young and sterile; they agree in form of pinnules, venation and scales, but differ in having rather numerous stout hairs on the upper surface of costules.

**167. *Cyathea robinsonii* COPEL.** Philip. J. Sc. 6 (1911) Bot. 145; v. A. v. R. Handb. Suppl. (1917) 30; COPEL. Fern Fl. Philip. 2 (1960) 203.—*C. pseudoalbizzia* COPEL. Philip. J. Sc. 38 (1929) 135; Fern Fl. Philip. 2 (1960) 203.

*Stipe* to at least 40 cm, warty where scales have fallen; scales pale to brownish, shining, to 20 mm long, edges setiferous; *main rachis* finely warty, bearing some hairs throughout, densely hairy towards apex of frond, hairs mixed with small pale scales. *Pinnae* to 40 cm long. *Pinnules* to 100 by 20 mm, the lowest with stalks 5–10 mm long; at base of larger pinnules 1–2 pairs of free tertiary leaflets, then several pairs of segments separately adnate by narrow bases to costa, rest of pinnule lobed nearly to costa; costules on larger pinnules 5–7 mm apart; lamina-segments firm, dark on upper surface when dry, edges almost entire; veins 5–6 pairs. *Sori* medial; indusium at first complete, rather firm, breaking irregularly and persistent. *Scales and hairs*: pinna-rachis and costae densely hairy and scaly on lower surface, hairs spreading, pale, 2 mm long, scales narrow, pale, sometimes setiferous; on lower surface of costules and veins abundant pale spreading hairs, no scales.

Type specimen: ROBINSON BS 9394, Mt Binuang, Luzon (MICH; dupl. at K, US, P, UC).

Distr. *Malaysia*: Philippines (Luzon).

Ecol. At 875–1150 m.

Note. The type of *C. pseudoalbizzia* is small, with pinnules to 70 by 12 mm.

**168. *Cyathea senex* v. A. v. R.** Bull. Jard. Bot. Btzig II, n. 16 (1914) 4; Handb. Suppl. (1917) 34.

*Stipe* densely scaly throughout, scales to 30 mm long, mostly not over 1 mm wide, pale, edges closely set with dark setae; *main rachis* similarly scaly near base only. *Pinnae* to 40 cm long; lowest pinnae somewhat reduced. *Pinnules* to 80 by 12 mm, lowest 1 or 2 segments almost free, rest of pinnule lobed to within 1 mm of costa; costules 3½ mm apart; lamina-segments firm, dark above when dry, edges crenate, sinuses narrow; veins to 6 or 7 pairs. *Sori* medial, indusium at first thin and complete, breaking and persistent; paraphyses pale. *Scales and hairs*: pinna-rachis bearing pale spreading hairs and many small pale setiferous scales; scales at base of costae narrow, pale, setiferous, grading to acuminate bullate scales at apex, spreading hairs present throughout; a few bullate scales present on costules, with many hairs; erect pale hairs also present on lower surface of veins; thick curved hairs scattered on upper surface of costules and veins.

Type specimen: MATTHEW 526-A, Mt Singalang, Sumatra (BO; dupl. at K).

Distr. *Malaysia*: Central Sumatra.

Ecol. At 1500–1800 m.

Note. MATTHEW gave the number 526 also to specimens of *C. sumatrana* BAK., which are at Kew, from the same locality.

**169. *Cyathea sibuyanensis* COPEL.** in Elmer, Leaf. Philip. Bot. 4 (1911) 1150; v. A. v. R. Handb. Suppl. (1917) 38; COPEL. Fern Fl. Philip. 2 (1960) 204.

*Stipe* not known. *Main rachis* closely warty on lower surface, bearing many very small dull scales. *Pinnae* to 35 cm long. *Pinnules* to 90 by mostly to 20 mm (on a lower pinna to 25 mm), lowest 1–2 pairs of segments quite free (lowest sometimes stalked) and deeply lobed at the base, then several segments contracted at the base and separately adnate to the costa, rest of pinnule lobed almost to the costa; costules 5–6 mm apart, decidedly oblique; lamina-segments firm, edges almost entire to crenate; veins 6–7 pairs, the lowest in lobes of basal segments pinnately branched. *Sori* medial; indusium pale and translucent, at first completely covering sorus, breaking and persistent. *Scales and hairs*: pinna-rachis closely warty and covered with very small dull scales, the largest setiferous, hairs also mixed with the scales, at least towards apex of pinna; costae scaly near base, hairy in apical half, scales mostly ovate-acute, hardly 1 mm long, brown, edges with a few setae or short hairs near tip, none bullate; costules bearing hairs on lower surface, but no hairs on veins; costules glabrous on upper surface.

Type specimen: ELMER 12513, Mt Giting-Giting, Sibuyan I. (MICH; dupl. at K, A, FI, US, BO, P, SYD, U, L).

Distr. *Malaysia*: Philippines (Sibuyan, one collection).

Ecol. Altitude 1450 m.

**170. *Cyathea philippinensis* BAK.** Ann. Bot. 5 (1891) 186; v. A. v. R. Handb. (1908) 16, 783; COPEL. Philip. J. Sc. 4 (1909) Bot. 111, incl. *var. nuda* COPEL.; v. A. v. R. Handb. Suppl. (1917) 23; COPEL. Fern Fl. Philip. 2 (1960) 205.—*C. bicolorana* COPEL. in Elmer, Leaf. Philip. Bot. 9 (Mar. 1920) 3108; Fern Fl. Philip. 2 (1960) 204.—*C. ramosiana* v. A. v. R. Bull. Jard. Bot. Btzig III, 2 (June 1920) 137; COPEL. Fern Fl. Philip. 2 (1960) 206.—*C. heteroloba* COPEL. Philip. J. Sc. 38 (1929) 134; Fern Fl. Philip. 2 (1960) 204.—*C. bontocensis* COPEL. Philip. J. Sc. 46 (1931) 209; Fern Fl. Philip. 2 (1960) 205.

*Stipe* 12–35 cm, base dark and warty; scales pale to brownish, to 25 by 2 mm, edges bearing concolorous setae. Lowest *pinnae* 4–10 cm long, largest to 30 cm. *Pinnules* to 65 by 15 mm, lowest 2–3 segments of larger pinnules free or nearly so, rest of pinnule lobed ½–¾ towards costa; costules 3½–5½ mm apart; lamina-segments entire, apex broadly rounded; veins 4–6 pairs. *Sori* nearer to costule than edge; indusium complete, thin, translucent, breaking and persistent. *Scales and hairs*: on lower surface of pinna-rachis narrow

pale setiferous scales; on costae at base elongate flat scales with pale fringe or dark setae, grading to pale bullate scales, pale thick hairs also usually present near apex of costa; on costules bullate scales, some fringed near apices, and usually also a few hairs; no hairs on upper surface of costules and veins.

Type specimen: *ex* Hort. Veitch, cult. Kew, origin Philippines, Feb. 1878 (K).

Distr. *Malaysia*: Philippines (Luzon, Mindoro).

Ecol. In mountain forest (only altitude records are 1400–1500 m).

Note. The type specimen is a frond of a small cultivated plant, bearing pinnules only 20 by 6 mm, but in general shape and in scales and sori it resembles the type specimens of the other species above cited, from which the present description is prepared.

**171. *Cyathea assimilis* HOOK.** Syn. Fil. (1865) 24; v. A. v. R. Handb. (1908) 20; COPEL. Philip. J. Sc. 4 (1909) Bot. 49.—*C. beccariana* CESATI, Atti Ac. Napoli 7<sup>a</sup> (1876) 3.—*C. dulitensis* BAK. Kew Bull. (1896) 40; v. A. v. R. Handb. (1908) 16; COPEL. Philip. J. Sc. 4 (1909) 33.—*C. ampla* COPEL. Philip. J. Sc. 6 (1911) Bot. 361; v. A. v. R. Handb. Suppl. (1917) 26; *non* HOLTUM, Rev. Fl. Mal. 2 (1954) 135.—*C. stipitulata* COPEL. Philip. J. Sc. 6 (1911) Bot. 362; v. A. v. R. Handb. Suppl. (1917) 29.

*Stipe* to 65 cm, medium to dark brown, finely warty, persistently scaly near base; scales medium brown, shining, firm, 15–20 by 1–2 mm, edges closely setiferous. *Lamina* to almost 200 cm long; largest *pinnae* to 55 cm long, more or less distinctly articulate to rachis, the lower *pinnae* with stalks to 4 cm long. Largest *pinnules* 80–90 by 25 mm, the lowest with stalks 4–8 mm, basal 1–2 lamina-segments quite free, next 1–2 pairs sometimes free with adnate base, rest of pinnule lobed to 1–2 mm from costa, apex evenly attenuate; in somewhat smaller pinnules only the basal basiscopic segment free, or no free segments; costules 5–7 mm apart; lamina-segments firm, edges more or less crenate, apices rounded; veins 8–10 pairs. *Sori* medial; indusium at first quite covering sorus, pale and thin, breaking irregularly and persistent. *Scales and hairs*: pinna-rachis beneath glabrous or with a few small setiferous scales; costae beneath near base bearing narrow strongly setiferous scales grading to small bullate setiferous scales distally and on costules; no hairs on lower surfaces of pinna-rachis, costae and costules.

Type specimen: LOBB *s.n.*, 1857, hills, Sarawak (K).

Distr. *Malaysia*: S. Sumatra (Mt Dempo), Borneo (Sarawak).

Ecol. Forests, 300–2000 m, the more coriaceous specimens in ridge-forest on sandstone.

Notes. The type collection of *C. dulitensis* was a small plant with largest *pinnae* only just pinnate at base; the later collection of RICHARDS from the same locality has amply bipinnate fronds, agreeing in other characters, and probably re-

presents the full development of the species. All specimens from Mt Dulit are much darker in all parts than those from elsewhere in Sarawak (*e.g.*, the type of *C. assimilis*) and have a thicker lamina, but do not differ in other characters. The specimen from Mt Dempo in Sumatra is dark like those from Dulit.

The type collection of *C. stipitulata* is an unusually small specimen, with pinnules 70 by 17 mm, costules 4½ mm apart and veins 6–7 pairs; it was found on Mt Matang, near Kuching, at 300 m.

In HOLTUM, Rev. Fl. Mal. 2 (1954) 135, the name *C. ampla* is wrongly given to a specimen of *C. polypoda* which has unusually wide pinnules; this latter species is quite exindusiate.

*C. assimilis* is closely related to *C. philippinensis* BAK. and appears to differ chiefly in the consistently larger size of all parts of the frond.

**172. *Cyathea trichodesma* (SCORT.) COPEL.** Philip. J. Sc. 4 (1909) Bot. 55.—*Alsophila trichodesma* SCORT. in Bedd. J. Bot. 25 (1887) 321; BEDD. Handb. Suppl. (1892) 3; v. A. v. R. Handb. (1908) 35.—*Alsophila margarethae* SCHROET. *ex* CHRIST, Ann. Jard. Bot. Botz 20 (1905) 136; v. A. v. R. Handb. (1908) 33.—*C. margarethae* COPEL. Philip. J. Sc. 4 (1909) Bot. 38; C. CHR. Gard. Bull. S.S. 7 (1934) 220.—*C. burbridgei* [*non* (BAK.) COPEL.] HOLTUM, Rev. Fl. Mal. 2 (1954) 124.

*Trunk* slender, to 4½ m. *Stipe* fairly long, near base densely scaly (not hairy), finely warty when scales have fallen; scales medium to light brown, shining, firm, rather dark brown when dried, to about 25 by 2 mm, edges closely set with short dark setae. *Frond* including stipe 2–3½ m long. *Pinnae*: lowest slightly reduced, largest about 60 cm long. *Pinnules* commonly to 90 by 15 mm, largest seen 110 by 20 mm, nearly sessile, shortly acuminate, lobed to about 2 mm from costa, no free basal segments; costules 4½–5 mm apart; veins 6–8 pairs; lamina-segments thin, crenate, sinuses narrow. *Sori* medial, often confluent at maturity; no indusium; paraphyses a little longer than sporangia. *Scales and hairs*: pinna-rachis, costae, costules and veins on lower surface bearing many pale spreading hairs 1–2 mm long; scales on costae and costules sparse, pale, some narrow and flat, some bullate, most bearing dark setae; hairs present on upper surface of costules and veins.

Type specimen: SCORTECHINI *s.n.*, Perak (BM).

Distr. *Malaysia*: Malay Peninsula (central part), Borneo (Sarawak, N. Borneo).

Ecol. Lowland forest, sometimes by rivers, to 1500 m in N. Borneo.

Notes. Bornean specimens are all smaller than those from the Malay Peninsula, the largest having pinnules to 70 by 15 mm; they also lack hairs on the upper surface of costules. In size, the Bornean specimens are nearer to *C. trichophora*, but the distribution of hairs is different.

In the Malay Peninsula has been found a specimen rather intermediate between *C. trichodesma* and *C. alternans*, both of which species were growing near it.



**173. *Cyathea wallacei* (METT. in KUHN) COPEL.** Philip. J. Sc. 4 (1909) Bot. 48.—*Alsophila wallacei* METT. in Kuhn, Linnaea 36 (1869) 153; v. A. v. R. Handb. (1908) 36.—*Alsophila burbridgei* BAK. J. Bot. 17 (1879) 38; v. A. v. R. Handb. (1908) 33.—*C. burbridgei* COPEL. Philip. J. Sc. 4 (1909) Bot. 55; non HOLTTUM, Rev. Fl. Mal. 2 (1954) 124, which is *C. trichodesma*.—*Gymnosphaera burbridgei* COPEL. Gen. Fil. (1947) 99.

*Stipe* 30 cm or more, pale and smooth above the base; scales at base light brown, firm, to 15 by 2 mm, setiferous; main *rachis* finely hairy on abaxial surface in apical part. Largest *pinna* seen 38 cm long. *Pinnules* to 65 by 13 mm, sessile, apex abruptly narrowed, lobed to within 1 mm of costa, lowest segment almost free; costules 3–3½ mm apart; lamina-segments thin, slightly crenate, sinuses narrow; veins 4–6 pairs, mostly simple. *Sori* medial, lacking indusia. *Scales and hairs*: lower surface of pinna-rachis, costae, costules and veins bearing pale spreading hairs 1 mm long; pale bullate scales present on costae and costules; upper surface of costules and veins bearing scattered long spreading hairs.

Type specimen: WALLACE *s.n.*, 1857, Borneo (original lost ?; dupl. at Kew).

Distr. *Malaysia*: Borneo (Sarawak; N. Borneo).

Ecol. In lowland forest, at least sometimes on poor sandstone soil.

Notes. The pinnules of this species are more deeply cut than those of other species of *sect. Schizocaena*, and have closer costules; they have the aspect of *sect. Sphaeropteris*, but are much smaller than normal in that section, and have hairiness like that of some members of *sect. Schizocaena*.

*Alsophila wallacei* was credited to METTENIUS by CHRISTENSEN, Ind. Fil., but it was described without author's name in the original paper.

**174. *Cyathea trichophora* COPEL.** Philip. J. Sc. 6 (1911) Bot. 363.—*C. poiensis* COPEL. l.c. 362.—*Alsophila poiensis* v. A. v. R. Handb. Suppl. (1917) 56.—*Alsophila trichophora* v. A. v. R. l.c. 72.—*C. mollis* COPEL. Philip. J. Sc. 12 (1917) Bot. 52; C. CHR. Gard. Bull. S.S. (1934) 220.—*C. ramosii* COPEL. Philip. J. Sc. 30 (1926) 325.—*Alsophila ramosii* C. CHR. Ind. Fil. Suppl. 3 (1934) 23.—*C. bipinnatifida* COPEL. Philip. J. Sc. 56 (1935) 97, pl. 2 (not *C. bipinnatifida* (BAK.) DOMIN, 1929).—*Gymnosphaera bipinnatifida* COPEL. Gen. Fil. (1947) 99.—*Gymnosphaera mollis* COPEL. l.c. 99.—*Gymnosphaera trichophora* COPEL. l.c. 99; Fern Fl. Philip. 2 (1960) 236.

*Trunk* to 50 cm. *Stipe* 25–50 cm, at least the basal part persistently scaly, scales to 20 by 3 mm, light brown, shining, edges setiferous; main *rachis* bearing more or less abundant narrow pale setiferous scales and also spreading hairs 2 mm long. *Pinnae*: lowest reduced and deflexed, largest 25–30 cm long. *Pinnules* 30–55 by 10–14 mm, lobed half-way to costa; costules 3½–4 mm apart; veins 3–5 pairs; lamina-segments thin, entire, ends rounded. *Sori* medial; no indusia; paraphyses not longer than sporangia. *Hairs* rather abundant on lower

surface of pinna-rachis and costae, sometimes on costules; some pale bullate scales present on costules.

Type specimen: RAMOS 949, Prov. Laguna, Luzon (MICH; dupl. at FI, UC).

Distr. *Malaysia*: Philippines (throughout), Borneo (Sarawak and N. Borneo).

Ecol. Apparently in low country forest, highest record 1200 m.

Notes. The type of *C. bipinnatifida* (from Basilan I.) is from a young plant, with simply pinnate frond bearing few sori; the upper pinnae are closely similar to pinnules of other specimens referable to *C. trichophora*. It may be that *C. trichophora* and *C. elliptica* should be united; the latter has a different distribution of hairs and has apparently only been found at higher altitudes.

**175. *Cyathea polypoda* BAK.** Trans. Linn. Soc. II, Bot. 4 (1894) 250; v. A. v. R. Handb. (1908) 18; C. CHR. Gard. Bull. S.S. 7 (1934) 219; HOLTTUM Rev. Fl. Mal. 2 (1954) 122.—*C. kemberangana* COPEL. Philip. J. Sc. 12 (1917) Bot. 52; C. CHR. Gard. Bull. S.S. 7 (1934) 219.—*Alsophila kemberangana* C. CHR. Ind. Fil. Suppl. 3 (1934) 22.—*Gymnosphaera dinagatensis* COPEL. Philip. J. Sc. 81 (1952) 19, pl. 14; Fern Fl. Philip. 2 (1960) 235.—*C. ampla* (non COPEL.) HOLTTUM, Rev. Fl. Mal. 2 (1954) 125.—*Gymnosphaera glabra* (non BL.) COPEL. Fern Fl. Philip. 2 (1960) 235.

*Trunk* to 3 m, covered with persistent leaf-bases; small branches often borne on lower part of trunk. *Stipe* to 80 cm, pale (green when living) to rather dark, densely scaly near base, finely warty after scales have fallen; scales shining medium brown, firm, to 30 by 2 mm, edges bearing close colorous setae; *rachis* and pinna-rachis glabrescent on lower surface. *Pinnae* to 60 cm long, lower ones long-stalked, not greatly reduced. *Pinnules* commonly 85 by 20 mm, sometimes to 110 by 27 mm, all stalked, stalks of lowest to 9 mm; basal 1–2 segments of lowest pinnules of largest pinnae quite free, then sometimes a pair with lamina adnate at base but free, rest of pinnule (whole of smaller pinnules) lobed to 1–2 mm from costa; costules 4½–5½ (sometimes to 6½) mm apart; veins 7–9 pairs, forked, acroscopic branch sometimes forked again; lamina-segments rather thick and rigid when dry, edges crenate, apices rounded, sinuses narrow except near base of largest pinnules. *Sori* nearer to costule than to edge; no indusium; paraphyses a little longer than sporangia. *Scales and hairs*: small dark to medium brown setiferous scales near base of costae; bullate scales, often setiferous, on costules, all scales often early caducous.

Type specimen: HAVILAND 1479, Mt Kinabalu, N. Borneo (K).

Distr. *Malaysia*: Malay Peninsula, Borneo (Sarawak, N. Borneo), Philippines (Panay, Mindanao).

Ecol. In open places on ridge-crests and summits, 600–2200 m; specimens from the higher elevations are decidedly coriaceous.

Note. BAKER described this species as indusiate;

he had a young frond on which bullate scales in some cases partly cover the immature sori.

**176. *Cyathea obscura*** (SCORT.) COPEL. Philip. J. Sc. 4 (1909) Bot. 37; HOLTUM, Rev. Fl. Mal. 2 (1954) 124.—*Alsophila obscura* SCORT. in BEDD. J. Bot. 25 (1887) 321, t. 278, fig. 2; Handb. Suppl. (1892) 3; v. A. v. R. Handb. (1908) 34; Suppl. (1917) 57.—*Alsophila subobscura* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 20 (1915) 1, t. 1; Handb. Suppl. (1917) 57.—*C. bartlettii* COPEL. Un. Cal. Publ. Bot. 14 (1929) 371.—*C. pulchra* COPEL. l.c. 372.—*C. subobscura* DOMIN, Pterid. (1929) 263.—*Alsophila bartlettii* C. CHR. Ind. Fil. Suppl. 3 (1934) 20.—*Alsophila pulchra* C. CHR. l.c. 23.—*Gymnosphaera pulchra* COPEL. Gen. Fil. (1947) 99.

*Stipe* dark to medium brown, densely scaly towards the base, finely warty where scales have fallen; scales 20–40 by 2–3½ mm, shining, pale brown, edges closely setiferous. *Pinnæ*: lowest somewhat reduced (sometimes only 10 cm long), largest 50 cm long. *Pinnules*: largest commonly 60–70 by 12–13 mm, largest seen 80 by 15 mm, on stalks 1–2 mm long, apex shortly acuminate, edges lobed ½–⅔ distance to costa; costules 3½–4 mm apart; veins about 6 pairs; lamina-segments firm, edges almost entire, apices bluntly pointed and asymmetric. *Sori* medial, on about 3 pairs of basal veins only, becoming quite confluent at maturity; no indusium; paraphyses copious, pale, much longer than sporangia. *Scales and hairs*: main rachis and pinna-rachis minutely warty and glabrescent beneath or bearing small setiferous scales; costae near base bearing very narrow dark-setiferous scales; costules bearing pale bullate scales often with dark setae near their apices; no hairs on lower surface; no hairs on upper surface of costules and veins.

Type specimen: SCORTECHINI s.n., Perak (BM; dupl. at K, SING).

Distr. *Malaysia*: Sumatra and Malay Peninsula. Ecol. In forest, 900–1400 m.

**177. *Cyathea agatheti*** HOLTUM, Kew Bull. 16 (1962) 51.

*Trunk* hardly 5 cm high. *Stipe* 35–75 cm, dark towards base which is covered with scales, slightly warty where scales have fallen, distal part and rachis pale (green when living), smooth and glabrous; scales on base of stipe to 10 by 2–2½ mm, light brown with somewhat paler edges which bear many rather long dark setae. *Lamina* 50–60 cm long; *pinnæ* distinctly articulate to rachis, lowest somewhat reduced, largest 18–25 cm long. *Pinnules* to 35 by 10 mm, abruptly narrowed at apex, lobed to within 1 mm of costa, lowest on stalks 1 mm long; costules 3 mm apart; lamina-segments thin, almost entire, sinuses narrow; veins 4–5 pairs, simple. *Sori* medial on veins; no indusia; paraphyses dark, shorter than sporangia. *Scales and hairs*: lower surface of costae bearing scattered spreading pale hairs, and a very few hairs on costules; scales very few, only seen on young frond, narrow, pale, ciliate; upper surface of costae, costules and veins bearing scattered long spreading

hairs in addition to the usual antrorse hairs on costae.

Type specimen: KOSTERMANS 12870, W. Kutai, E. Borneo (BO; dupl. at K, L).

Distr. *Malaysia*: E. Borneo (one collection).

Ecol. In *Agathis*-forest on water-logged white acid sand, 600 m.

**178. *Cyathea squamulata*** (BL.) COPEL. Philip. J. Sc. 4 (1909) Bot. 37; HOLTUM, Rev. Fl. Mal. 2 (1954) 122, fig. 49.—*Gymnosphaera squamulata* BL. En. Pl. Jav. (1828) 243; COPEL. Gen. Fil. (1947) 99; Fern Fl. Philip. 2 (1960) 235.—*Alsophila squamulata* HOOK. Sp. Fil. 1 (1844) 51, p.p.; METT. Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 52; RACIB. Fl. Btzig 1 (1898) 33; v. A. v. R. Handb. (1908) 33; Suppl. (1917) 56.—*Alsophila comosa* WALL. ex HOOK. Sp. Fil. 1 (1844) 53; Syn. Fil. (1865) 41; BEDD. Ferns Br. Ind. (1865) pl. 84; Handb. (1883) 13.—*Alsophila laeta* KUNZE, Bot. Zeit. 4 (1846) 476, p.p.—*Alsophila oligosora* MIQ. Verh. Kon. Ned. Inst. Wet. 3, pt 4 (1851) 43.—*Alsophila ridleyi* BAK. Ann. Bot. 8 (1894) 122; v. A. v. R. Handb. (1908) 32.—*C. ridleyi* COPEL. Philip. J. Sc. 4 (1909) Bot. 36.—*C. brooksii* COPEL. *ibid.* 6 (1911) Bot. 135, pl. 16, not *C. brooksii* MAXON, 1904.—*C. paraphysata* COPEL. l.c. 135, pl. 15.—*Alsophila sarawakensis* C. CHR. Ind. Fil. Suppl. (1913) 5.—*Alsophila xantholepis* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 23 (1916) 1; Handb. Suppl. (1917) 489, not *Alsophila xantholepis* CHRIST, 1899.—*Alsophila paraphysata* v. A. v. R. Handb. Suppl. (1917) 58.—*Alsophila allocota* v. A. v. R. Bull. Jard. Bot. Btzig III, 5 (1922) 180.—*Alsophila glabrescens* v. A. v. R. l.c. 181.—*C. deuterobrooksii* COPEL. Philip. J. Sc. 38 (1929) 131.—*C. allocota* DOMIN, Acta Bot. Bohem. 9 (1930) 89.—*C. glabrescens* DOMIN, l.c. 119.—*C. xanthina* DOMIN, l.c. 172.—*Alsophila xanthina* C. CHR. Ind. Fil. Suppl. 3 (1934) 24.—*Gymnosphaera sarawakensis* COPEL. Gen. Fil. (1947) 99.—Fig. 8c, 29c-d.

*Trunk* to c. 2 m. *Stipe* 40–60 cm, densely and persistently scaly for most of its length (main rachis sometimes also persistently scaly); scales firm, medium brown, largest 30 by 2–3 mm (rarely to 40 by 4 mm), edges closely set with dark setae. *Frond* to c. 150 cm long. *Pinnæ*: lowest somewhat reduced, variable; largest 50 cm long. *Pinnules* commonly to 80 by 15 mm, largest seen 100 by 20 mm, lower ones on stalks 1–2 mm long, apex shortly acuminate, edges lobed ½–⅔ distance towards costa, no free basal segments but pinnules on exceptionally large pinnæ sometimes lobed nearly to costa at base; costules 3½–4½ mm apart; veins 6–9 pairs, of smaller pinnules mostly simple, of larger ones mostly forked; lamina-segments rather thin, edges almost entire, apices rounded and asymmetric. *Sori* a little nearer to costule than to edge; no indusia; pale paraphyses usually longer than sporangia. *Scales and hairs*: pinna-rachis glabrescent beneath, finely warty, sometimes with residual small setiferous scales; on costae, near base, usually narrow flat brown strongly setiferous scales, grading to bul-

late ones distally; on costules pale bullate scales, the larger ones acuminate and setiferous near apices; a few stout hairs on upper surface of costules.

Type specimen: KUHLE & VAN HASSELT, Pasir Ipi, W. Java (L).

Distr. *Malaysia*: Sumatra, Malay Peninsula, Java, Borneo, S. Philippines (Sulu Arch.).

Ecol. A small tree-fern of forest, not in open places, in lowlands and to c. 1500 m (rarely above 1000 m in the Peninsula); specimens from 2500 m

have been found on Mt Kinabalu, N. Borneo, and are small, with exceptionally scaly rachis, but do not appear to differ significantly in other ways.

Note. The type specimens of *Alsophila comosa* and *A. ridleyi* are both from Singapore I. The latter is only distinct in smaller size and less deeply lobed pinnules. Similar differences characterize the other species reduced to synonymy. The type collection of *C. squamulata* includes a small frond only 60 cm long in all, with pinnae to 8 cm long and very few free pinnules, but fertile.

#### 4b. Subsection *Sarcopholis*

HOLTUM, *subsect. nov.*—Fig. 30.

*A subsezione Schizocaena differt: paleis stipitis carnosis ascendentibus, apices versus planis setiferisque.*

Type species: *Cyathea rosenstockii* BRAUSE.

Distr. *Malaysia*: Moluccas and New Guinea to Polynesia.

Taxon. Fleshy upcurved bases of stipe-scales (fig. 30) are the distinctive character of this subsection; distally these fleshy bases are more or less abruptly flattened to scales which have setiferous margins. The flat distal parts are often eroded from herbarium specimens; a careful morphological and developmental study from good fresh material is needed. Some species have the fleshy bases less developed, and I am not sure that there is a sharp distinction from *subsect. Schizocaena*. The scale-bases in *C. pulcherrima* COPEL. (*subsect. Sphaeropteris*) are comparable developments, but they are slender, rigid, and spread at right angles to the surface of the stipe.

#### KEY TO THE SPECIES

1. Pinna-rachis hairy on the lower surface.
2. Scales on costae setiferous.
3. Few or no bullate scales. Pinnules lobed to 2 mm from costa . . . . . 179. *C. fusca*
3. Bullate scales present. Pinnules lobed to within 1 mm from costa . . . . . 180. *C. setifera*
2. Scales on costae not setiferous. . . . . 181. *C. rosenstockii*
1. Pinna-rachis not hairy on lower surface.
4. Indusium quite lacking.
5. Pinnules almost sessile, to 28 mm wide . . . . . 182. *C. marginata*
5. Pinnules long-stalked, to 45 mm wide . . . . . 183. *C. mesosora*
4. Indusium present.
6. Pinnules on stalks to 6 mm long. Stipe to 60 cm . . . . . 184. *C. papuana*
6. Pinnules sessile or on much shorter stalks. Stipe much shorter.
7. Pinnules to 35 mm wide, larger ones with lowest 1-2 lamina-segments free. No bullate scales. . . . . 185. *C. inaequalis*
7. Pinnules rarely over 25 mm wide, lowest segments not free. Bullate scales usually present on costules.
8. Pinnules lobed only in basal half . . . . . 186. *C. parvipinna*
8. Pinnules deeply lobed throughout.
9. Pinnules not over 20 mm wide, lobed to c. 3 mm from costa . . . . . 187. *C. werneri*
9. Pinnules on largest pinnae in most cases over 20 mm wide, lobed to 1-2 mm from costa.
10. Scales on costae and costules bullate, mostly entire . . . . . 188. *C. insularum*
10. Scales on costae mostly small and fringed or setiferous; bullate scales on costae and costules mostly fringed.
11. Pinnules of largest pinnae 22-28 mm wide.
12. Segments of lamina narrowed rather evenly from base to pointed apex, sinuses thus triangular. Scales on costae not setiferous; bullate scales few. Lowest pinnae not greatly reduced. . . . . 189. *C. tripinnatifida*
12. Segments of lamina with rounded apex. Scales on costae often setiferous, bullate scales usually present. Lowest pinnae small, stipe very short . . . . . 190. *C. runensis*
11. Pinnules of largest pinnae less than 20 mm wide . . . . . 191. *C. moseleyi*

**179. *Cyathea fusca* BAK.** in Beccari, Malesia 3 (1886) 31; v. A. v. R. Handb. (1908) 19; Suppl. (1917) 25; COPEL. Philip. J. Sc. 77 (1947) 100.

*Trunk* to 2 or 3 m; fronds to 150 cm long. *Stipe* to 15 cm, bearing thick fleshy scales which have dark setae on their edges (at least when young); *rachis* bearing similar scales near base, also short hairs on lower surface. *Pinnae*: lowest c. 8 cm long, largest 40 cm. *Pinnules* to c. 90 by 20 mm, lobed to 2–3 mm from costa, lowest segment not free; costules 5 mm apart; lamina-segments firm, almost entire, apices rounded; veins c. 6 pairs. *Sori* medial, indusiate; indusium complete, pale, breaking and largely persistent. *Scales and hairs*: pinna-rachis densely hairy on lower surface, hairs spreading, c. 1/2 mm long; some similar hairs on bases of costae; scales on costae very small, bearing long dark setae; a few similar scales on costules, none bullate; no hairs on upper surface of costules and veins.

Type specimen: D'ALBERTIS *s.n.*, Fly R., Papua (K).

Distr. *Malaysia*: Eastern New Guinea.

Ecol. Casual in undergrowth of forest near river (BRASS).

Note. This species is very near *C. wernerii* ROSENST., but appears to differ from it in presence of abundant hairs on lower surface of pinna-rachis and in absence of bullate scales.



Fig. 30. *Cyathea rosenstockii* BRAUSE. Base of stipe, showing fleshy scales; scale in cm (PULLE 509, Mt Perameles, 1100 m, BM).

**180. *Cyathea setifera* HOLTUM,** Kew Bull. 16 (1962) 62.

*Stipe* 10 cm, covered with thick dark pale-edged scales 20 by 1 1/2 mm, their edges (at least near apex) bearing dark setae; also covered, between the large scales, with a thin dark felt of small scales of irregular shape, some with dark setae; scales of very young fronds very thick at their bases which have internal air-spaces. *Rachis* bearing scattered narrow dark scales 10 mm long and also thick hairs, and the remains of a felt of small scales as on the stipe. *Pinnae*: lowest about 4 cm long, largest 40 cm. *Pinnules* to 70 by 16 mm, sessile, very shortly acuminate, lobed nearly to the costa; basal 1–2 segments contracted at base; costules 4–4 1/2 mm apart, at 60° to the costa; lamina-segments rigid but not very thick, entire or slightly crenulate, ends rounded; veins 6–7 pairs, strongly raised on lower surface, forked rather far from costule. *Sori* nearer to edge than to costules; indusium thin and pale, breaking and persistent; paraphyses dark, longer than sporangia. *Scales and hairs*: upper part of main rachis and pinna-rachis bearing thick pale hairs on lower surface, also scattered dark strongly setiferous scales of various sizes, to 5 mm long; costae densely covered beneath with elongate brown setiferous scales, grading to brown bullate scales setiferous near their apices; bullate scales distally on costae and on costules brown, pale-fringed at apices; hairs on upper surface of costules few (not more than 1 on a costule).

Type specimen: MAIN & ADEN 1306, Morotai, N. Moluccas (BO; dupl. at K, L).

Distr. *Malaysia*: Moluccas (Morotai), one collection.

Ecol. At 1000 m.

**181. *Cyathea rosenstockii* BRAUSE,** Bot. Jahrb. 56 (1920) 49; COPEL. Philip. J. Sc. 77 (1947) 101.—Fig. 30.

*Trunk* 1 1/2–2 m, bearing 6–8 fronds. *Stipe* 10–15 cm, covered with thick ascending fleshy scales to 45 by 4 mm wide at base; main *rachis* almost smooth, glabrescent, pale. *Pinnae*: lowest 3–5 cm long, increasing upwards, largest 30 cm. *Pinnules* to 85 by 23 mm, sessile, lowest segment a little constricted at base, rest of pinnule lobed to 1 mm from costa; costules 5–5 1/2 mm apart, distinctly oblique; lamina-segments rigid, edges slightly crenate, sinuses wider in fertile than in sterile pinnules; veins 7–10 pairs, much raised on upper surface, less so beneath. *Sori* nearer costule than edge; indusium thin, at first complete, later breaking and sometimes almost disappearing. *Scales and hairs*: lower surface of pinna-rachis throughout bearing many pale thick crisped hairs; scales on lower surface of costae and costules dark, bullate, sometimes very few.

Type specimen: LEDERMANN 11264, Sepik area, E. New Guinea (B).

Distr. *Malaysia*: New Guinea.

Ecol. In mossy forest, or rain forest, at 1300–1750 m.

**182. *Cyathea marginata* (BRAUSE) DOMIN**, Acta Bot. Bohem. 9 (1930) 134.—*Alsophila marginata* BRAUSE, Bot. Jahrb. 56 (1920) 63.

*Trunk* to 3 m tall; fronds 150–200 cm long. *Stipe* to at least 35 cm, warty, with one pair of reduced pinnae near base; stipe-scales not seen. *Pinnae*: lowest 18 cm long, largest 42 cm. *Pinnules* to 125 by 28 mm, sessile, acuminate, lobed to 2–3 mm from costa, lowest segment not free; costules 6–7 mm apart; lamina-segments rather thick and rigid, crenulate, apices rounded, sinuses narrow; veins 11–12 pairs. *Sori* medial; no indusium; receptacle large. *Scales and hairs*: pinna-rachis beneath light brown, smooth, with a few persistent pale thin scales bearing irregular long flexuous setae; costal scales few, thin, ovate, bearing long dark setae; no scales seen on costules.

Type specimen: LEDERMANN 12586, Sepik region, E. New Guinea (B).

Distr. *Malaysia*: E. New Guinea (one collection).

Ecol. In mountain forest at 1400–1500 m.

**183. *Cyathea mesosora* HOLTUM**, Kew Bull. 16 (1962) 57.

*Trunk* slender, to 3 m. *Fronds* few, 150–220 cm long. *Stipe* to 10 cm, dull, spines to 1 mm, rather abundant; scales to c. 15 by 1¼ mm, slightly thickened at base, dark, edges bearing irregular flexuous setae or hairs. *Pinnae*: lowest 3–5 cm long, simply pinnate (sometimes widely separated from next); largest 42 cm long. *Pinnules* widely spaced, to 110 by 45 mm, lowest on stalks to 8 mm long, lobed throughout to 3–4 mm from costa; costules 7½–9 mm apart; lamina-segments very firm, edges crenate (more strongly towards apex) and thickened, apex rounded; veins 10–12 pairs on largest pinnules, mostly rather narrowly forked, strongly raised on lower surface. *Sori* medial, usually at the fork of a vein, sometimes one sorus in middle of each branch of lowest vein; no indusium; receptacle large, often very broad; paraphyses short, pale, slender. *Scales and hairs*: pinna-rachis beneath smooth and glabrous; no scales seen on lower surface of costae and costules; minute hairs (bases of former scales?) sometimes abundant on lower surface of veins; no hairs on upper surface of costules and veins.

Type specimen: CARR 15720, Lala River, Papua (BM; dupl. at K, L, MICH).

Distr. *Malaysia*: Eastern New Guinea (three collections).

Ecol. In forest at 1400–1750 m.

**184. *Cyathea papuana* (RIDL.) v. A. v. R.** Handb. Suppl. (1917) 487; COPEL. Philip. J. Sc. 77 (1947) 121.—*Alsophila papuana* RIDL. Trans. Linn. Soc. II, Bot. (1916) 252.—*Gymnosphaera papuana* COPEL. Gen. Fil. (1947) 98.

*Stipe* to 60 cm, reduced basal pinnae lacking; spines and scales as *C. mesosora*. *Pinnae* to more than 40 cm long. *Pinnules* to 90 by 22 mm, lobed to 3 mm from costa, lowest on stalks to 6 mm long; costules 5–7 mm apart; lamina-segments firm, edges thick, crenate; veins to 8 or 9 pairs, thick

and raised on lower surface. *Sori* medial, indusiate; indusium thin and translucent, at first complete, breaking and in part persistent; paraphyses short, thin, pale. *Scales and hairs*: residual scales on pinna-rachis and costae few, narrow with irregular long dark setae; no hairs on upper surface of costules and veins.

Type specimen: BODEN KLOSS, Mt Carstensz, Camp III, Jan. 1913, W. New Guinea (BM; dupl. at K).

Distr. *Malaysia*: West New Guinea (two collections).

Ecol. At 700–1100 m.

**185. *Cyathea inaequalis* HOLTUM**, Kew Bull. 16 (1962) 56.

*Trunk* 4–6 m, 5–6 cm ø; leaf-scars in alternate whorls of 5. *Stipe* 24 cm, copiously thorny and scaly near the base; thorns 1 mm, acute; scales ascending, fleshy at their bases and thinner distally, to 20 by 1½ mm, dark and shining except for the thin pale edges of the distal part which bear dark setae; scales above base of stipe very small, brown, the larger ones setiferous. *Pinnae*: lowest 8 cm long, pinnatifid, largest 50 cm long. *Pinnules* to 130 by 35 mm, lowest with stalks 3 mm long, apex acuminate, base very unequal (acroscopic segment much larger than basiscopic), 1–2 basal segments of largest pinnules free or nearly so, rest of pinnule lobed to 2 mm from costa; costules 7½–8½ mm apart; lamina-segments thin, almost entire, apex bluntly pointed and slightly falcate; veins to 9 pairs. *Sori* medial; indusia complete, thin, breaking and persistent. *Scales and hairs*: pinna-rachis minutely warty beneath, glabrescent; near base of costae a few small flat elongate setiferous scales; no scales seen on costules; no hairs on lower surface of pinnules, nor on upper surface of costules.

Type specimen: BRASS 23547, Mt Dayman, Milne Bay Distr., Papua (L; dupl. at A).

Distr. *Malaysia*: E. New Guinea (once collected).

Ecol. In rain forest ravine, at 700 m.

**186. *Cyathea parvipinna* HOLTUM**, Kew Bull. 16 (1962) 60.

*Trunk* 1 m tall. *Stipe* 20 cm; spines on stipe and basal part of rachis many, sharp, 1 mm; scales on stipe sparse, to 10 by 2 mm, thick at base, narrowed and thinner distally with paler edges bearing dark setae; also on stipe very small brown scales, the larger setiferous. *Pinnae*: lowest 3½ by 1 cm, on stalks 8 mm long, lamina simple; largest 40 cm long. *Pinnules* to 90 by 18 mm, sessile, acuminate, apical half subentire, basal half gradually more deeply lobed, at base lobed more than half-way to costa, lobes almost entire, thin; costules 5 mm apart; veins in basal lobes 6–7 pairs. *Sori* medial; indusia thin, translucent, breaking and in part caducous; paraphyses pale. *Scales and hairs*: pinna-rachis glabrescent beneath, residual scales small, brown, sparingly setiferous; a few rigid brown setiferous scales at bases of costae; on distal part of costae small dark thick bullate scales; no scales seen on costules; no hairs on lower

surface of costae and none on upper surface of costules.

Type specimen: BRASS 25837, Normanby I., Papua (L; dupl. at K, US).

Distr. *Malaysia*: E. New Guinea (once collected).

Ecol. On banks of stream in forest at 270 m.

**187. *Cyathea wernerii* ROSENST.** in Fedde, Rep. 5 (1908) 34; v. A. v. R. Handb. (1908) 786; COPEL. Philip. J. Sc. 77 (1947) 101.—*C. kingii* ROSENST. in Fedde, Rep. 9 (1911) 422, *non* (CLARKE) COPEL. 1909; v. A. v. R. Handb. Suppl. (1917) 25; COPEL. Philip. J. Sc. 77 (1947) 100.

*Trunk* to 3½ m, bearing c. 8 fronds to 2½ m long. *Stipe* 8–25 cm; scales to 20 by 1½ mm, thick at base, pale and thin distally with setae on the edges. *Pinnae*: lowest 3–8 cm long, longest to at least 50 cm. *Pinnules* to 100 by 20 mm, sessile, acuminate, lobed to c. 3 mm from costa; costules 5½–6½ mm apart; lamina-segments almost entire, distinctly narrowed from the base so that sinuses are triangular. *Sori* medial; indusium complete, thin, breaking and persistent; paraphyses dark. *Scales and hairs*: pinna-rachis glabrescent beneath or with small residual scales, not hairs; scales on costae near base small, bearing some dark setae, usually grading to bullate scales distally and on costules; a few thick hairs sometimes near apex of costae on lower surface.

Type specimen: WERNER 66, Damun, NE. New Guinea (S-PA; dupl. at P).

Distr. *Malaysia*: S. & E. New Guinea.

Ecol. In forest at 200–1200 m.

Notes. WAKEFIELD has noted that plants are often fertile when juvenile (*i.e.* bearing only simply pinnate fronds). Some specimens lack bullate scales, and are then intermediate between this species and *C. fusca*; possibly the two should be united.

**188. *Cyathea insularum* HOLTUM**, Kew Bull. 16 (1962) 57.

*Trunk* 3–5 m, 3½–6 cm ø after decay of leaf-bases; leaf-scars 18–25 mm ø, in 3 rather steep spirals. *Fronds* numerous, 165–200 cm long. *Stipe* 10–15 cm, near base covered with scales; scales 10–15 by 1 mm, dark and thick at the base, distal part dark with pale edges bearing dark setae; rest of stipe sparsely covered with very small pale short-fringed scales. Lowest *pinnae* less than 5 cm long, rest gradually larger, largest 45 cm. Largest *pinnules* 65–90 by 18–22 mm, sessile, acuminate, lobed to 1–2 mm from costa; costules 5–6 mm apart; lamina-segments slightly crenate towards obtusely pointed apex; veins 8–9 pairs. *Sori* medial; indusium complete, thin, pale, breaking and persistent. *Scales and hairs*: pinna-rachis below bearing small thin pale finely fringed scales; scales on costae throughout pale, bullate, rather large, mostly entire; similar scales on costules; a few thick hairs towards apex of costa on lower surface, no hairs on upper surface of costules.

Type specimen: BRASS 27419, Misima Island, Louisiades (L).

Distr. *Malaysia*: Louisiade Arch. (on 4 islands). Ecol. In forest, near streams, at 100–350 m.

**189. *Cyathea triplinatifida* ROXB.** Calc. J. Nat. Hist. 4 (1844) 518.—*C. integra* J. Sm. ex Hook. Ic. Pl. (1844) t. 638, p. p. excl. ic.—*C. nigrospinulosa* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 28 (1918) 15.

*Stipe* to 25 cm (sometimes much shorter ?), bearing scattered thick scales to 20 by 1½ mm, setiferous near their apices; stipe also covered with very small dull fringed scales. *Pinnae* to at least 55 cm long. Largest *pinnules* 90–110 by 20–28 mm, lobed to 1½–2 mm from costa, sessile, short-acuminate; costules 6–7 mm apart; lamina-segments thin but firm, narrowed from the base to broadly pointed apex and so separated by triangular sinuses, edges crenate to almost entire; veins to 8 or 9 pairs. *Sori* nearer to costule than to edge; indusia rather thin, at first complete, breaking and persistent; paraphyses dark, as long as sporangia. *Scales and hairs*: lower surface of pinna-rachis bearing small pale fringed scales, hairs lacking; scales on costae small, fringed with pale hairs, not bullate; a few bullate scales on costules, sometimes caducous; a few thick hairs sometimes present on lower surface of costae and costules near apex of pinnule.

Type specimen: Herb. Wallich n. 7076, Moluccas (CAL ?; dupl. at K, BM).

Distr. *Malaysia*: Moluccas (Ambon).

Ecol. In lowland forest.

Notes. HOOKER cited a specimen of this species, from Ambon, with his original description of *C. integra*, but his illustration was prepared from a Philippine specimen, which is thus taken as type of *C. integra*.

Most specimens of *C. triplinatifida* lack the stipe. One from Ambon, collected by REINWARDT (L) has a stipe at least 25 cm long, and does not show lower pinnae.

**190. *Cyathea runensis* v. A. v. R.** Bull. Dép. Agr. Ind. Néerl. n. 18 (1908) 1; Handb. (1908) 22.—*C. versteegii* CHRIST, Nova Guinea 8 (1909) 161; v. A. v. R. Handb. Suppl. (1917) 25.

*Stipe* short, warty; scales dull, dark, more than 1 cell thick at base not fleshy as in *C. rosenstockii*. Lowest *pinnae* short, gradually increasing upwards, largest at least 50 cm long. *Pinnules* to 120 by 25 mm (rarely to 30 mm), lowest segment of largest pinnules free or nearly so, rest lobed to 2 mm from costa; costules 6–7 mm apart; segments of lamina almost entire or slightly crenate, apices rounded, separated by sinuses 1–2 mm wide; veins to 8 pairs. *Sori* medial; indusium complete, thin, persistent, breaking irregularly; paraphyses dark, as long as sporangia. *Scales and hairs*: pinna-rachis glabrescent on lower surface, hairs on upper surface short and dark; scales on lower surface of costae small, brown, of rather irregular shape, edges set closely with short spreading rather stiff concolorous hairs or darker setae; bullate scales on costules few, small.

Type specimen: TEYSMANN, Pulu Roon, W. New Guinea (BO; dupl. at L).

Distr. *Malaysia*: W. New Guinea, Bismarck Arch. Ecol. In lowland forest.

Note. This species is very close to *C. tripinnatifida*, and I am not sure of a clear distinction. It seems probable however that a short stipe is invariable in *C. runensis*, that of *C. tripinnatifida* being longer, but very few specimens show this character.

191. *Cyathea moseleyi* BAK. J. Linn. Soc. Bot. 15 (1876) 104.

*Stipe* short; stipe and lower part of rachis bearing scales to 20 by  $1\frac{1}{2}$  mm, dark and somewhat thickened in the middle with pale edges bearing dark setae. *Pinnæ*: lowest gradually reduced, largest to at least 45 cm long. Largest *pinnules* to 80 by 18 mm, lobed to c. 1 mm from costa, sessile, acuminate; costules 5–6 mm apart; lamina-segments rather thin, edges more or less crenate, apices bluntly pointed; veins 8–10 pairs. *Sori* medial; indusium pale, thin, at first complete, breaking and persistent; paraphyses dark. *Scales and hairs*: pinna-rachis beneath smooth, usually with some residual very small dull brown fringed scales; small fringed scales present on lower surface of costae, with small fringed bullate scales, the latter also abundant on lower surface of costules; a few thick hairs present on upper surface of costules but not on lower surface.

Type specimen: MOSELEY, Admiralty Is (K). Distr. *Malaysia*: Admiralty Is, Bismarck Arch. Ecol. In lowland forest.

Note. *C. brackenridgei* METT., of the Solomon Is, appears to be closely related to this species, but to differ in wider pinnules (to 24 mm wide) and in very abundant scales throughout the stipe and lower part of rachis.

#### Doubtful species

*Alsophila hallieri* ROSENST. Med. Rijksherb. n. 31 (1917) 2.—*C. hallieri* DOMIN, Acta Bot. Bohem. 9 (1930) 120.

The specimens of HALLIER (735, 737, 738, 4726, 4727) cited with the description have not been found in the Rijksherbarium at Leiden. The brief description does not permit the species to be identified with certainty.

*Alsophila matthewii* CHRIST, J. Linn. Soc. Bot. 39 (1909) 213.—*C. matthewii* DOMIN, Pterid. (1929) 263.

I have only seen the specimen from the type collection at Kew; it is a small sterile frond, evidently from an immature plant, said to have been borne on a slender trunk 60 cm high. As the specimen was found in a much-collected locality (Mt Maquiling, Luzon, at 1100 m), it probably belongs to a species already known, possibly *C. heterochlamydea* COPEL., but I am very uncertain of this.

*Alsophila philippinense* Hort. Veitch, Gard. Chron. II, 4 (1875) 179, *nomen*.—*C. veitchiana* DOMIN, Acta Bot. Bohem. 9 (1930) 168.

A cultivated plant, described as follows: "a handsome new fern, with regularly crimped pinnæ from the Philippine Islands". There is no specimen in Kew Herbarium, and no reference to the plant in Hortus Veitchii.

*Alsophila speciosa* [non (MEYEN) PRESL] GOLDMANN, Nova Acta 19, Suppl. I (1843) 465.

The type of MEYEN's species came from Brazil; GOLDMANN's brief Latin description of a Philippine fern is inadequate for identification.

*Cyathea adenochlamys* CHRIST, Bull. Herb. Boiss. II, 6 (1906) 1008; v. A. v. R. Handb. (1908) 785.

I have not found the type specimen at Paris. CHRIST described the indusia as persistent, rigid, green, covered densely with pale sessile glands, opening transversely; I have not seen any *Cyathea* with such indusia.

*Cyathea grata* DOMIN, Acta Bot. Bohem. 9 (1930) 120, *nomen*.

Under this name is cited *C. frondosa* ROSENST. in Fedde, Rep. 12 (1913) 163, but no such species is there described, nor have I found any other reference to *C. frondosa* ROSENST. Provenance New Guinea.

#### Species not occurring in Malaysia

*Alsophila truncata* BRACK. in Wilkes, U.S. Expl. Exped. 16 (1854) 289; v. A. v. R. Handb. (1908) 42.

Malaysian specimens referred to this species are *C. celebica* BL. or an allied species.

*Cyathea aneitensis* Hook. Syn. Fil. (1865) 26; v. A. v. R. Handb. (1908) 16.

After citing specimens from Aneitijum, HOOKER added "Ternate, Herb. Hort. Calc." There is no Ternate specimen at Kew, and I have seen no Malaysian specimens referable to this species.

*Cyathea rumphii* DESV. Mém. Soc. Linn. Paris 6 (1827) 323.—*Polypodium arboreum* LOUR. Fl. Coch. (1790) 831, *non* LINN.

DESLAUX published a new name for LOUREIRO's species, without description; like LOUREIRO, he also cited a plate by RUMPHIUS. LOUREIRO described a fern from Indo-China, not Amboin; neither his description, nor RUMPHIUS's plate is clearly identifiable. Therefore I cannot agree with MERRILL's suggestion that the name *C. rumphii* DESV. should replace *C. amboinensis* (v. A. v. R.) MERR. (see Trans. Am. Phil. Soc. Philad. n.s. 24, 1935, 57).

#### Excluded from *Cyathea*

*Alsophila dielsii* BRAUSE, Bot. Jahrb. 56 (1920) 67.—*C. dielsii* DOMIN, Acta Bot. Bohem. 9 (1930) 111.

The type specimen belongs to the genus *Di-plazium*.



*Alsophila dryopteroides* BRAUSE, Bot. Jahrb. 56 (1920) 70.—*C. atrispora* DOMIN, Acta Bot. Bohem. 9 (1930) 95.—*Dryopteris atrispora* C. CHR. Brittonia 2 (1937) 296.—*Lastrea dryopteroides* COPEL. Gen. Fil. (1947) 138.

The type is a Thelypteroid fern; generic limits in this group need to be clarified.

*Alsophila gazellae* KUHN, Forschungsr. Gazelle 4 (1889) 13.—*C. gazellae* DOMIN, Pterid. (1929) 262.

I have seen the type specimen, and identified it as *Pleocnemia cumingiana* PRESL (see Reinwardtia 1, 1951, 188).

*Alsophila tristis* (BL.) BL. ex MOORE, Ind. Fil. (1857) 58, based on *Aspidium triste* BL. En. Pl. Jav. (1828) 169 = *Stenolepia tristis* (BL.) V. A. v. R. Bull. Dép. Agr. Ind. Néerl. n. 27 (1909) 45.

*Alsophila warburgii* CHRIST, Ann. Jard. Bot. Btzg 15 (1897) 80, from Celebes = *Dryopteris* sp.

*Alsophila xantholepis* CHRIST ex DIELS in E. & P. Pfl. Fam. 1, 4 (1899) 138; v. A. v. R. Handb. (1908) 44.—*C. xantholepis* DOMIN, Pterid. (1929) 263; Acta Bot. Bohem. 9 (1930) 172 = *Dryopteris* sp.

*Cyathea aspidioides* (BL.) ZOLL. & MOR. Syst. Verz. (1846) 108 = *Diacalpe aspidioides* BL.

*Cyathea woodlarkensis* COPEL. Philip. J. Sc. 9 (1914) Bot. 1; *ibid.* 77 (1947) 124.—*Alsophila woodlarkensis* C. CHR. Ind. Fil. Suppl. 2 (1917) 4.

This is a large species of *Thelypteris*, apparently near *T. immersa* (BL.) CHING. There are specimens in Herb. Copel. (MICH) and at Paris.

## 2. DICKSONIA

L'HÉRIT. Sert. Angl. (1788) 30, *p.p.*; CHRIST, Farnkr. Erde (1897) 313, *p.p.*; DIELS in E. & P. Pfl. Fam. 1, 4 (1899) 119; UNDERW. Mem. Torr. Bot. Cl. 6 (1899) 259, 278; C. CHR. Ind. Fil. (1905) xvi, 220; MAXON, J. Wash. Ac. Sc. 12 (1922) 454; COPEL. Gen. Fil. (1947) 48.—*Balantium* KAULF. En. Fil. Chamisso (1824) 288, *p.p. typ.*; PRESL, Tent. Pterid. (1836) 134 (*excl. Balantium brownianum*).—*Dicksonia subg. Balantium* HOOK. Sp. Fil. 1 (1844) 66, *p.p.*—*Dicksonia* § *Eudicksonia* HOOK. & BAK. Syn. Fil. (1868) 50, *p.p.*—**Fig. 31.**

*Stem* arborescent, bearing numerous fronds in several spiral series, the vascular tissue supported both internally and externally with strong bands of sclerenchyma; leaf-bases usually persistent; young leaves, and at least the bases of stipes, persistently covered with long hairs; *stipes* usually short, vascular system complex, in two continuous or divided transverse arcs concave adaxially; *pinnae* numerous, the lower ones gradually reduced; pinnules usually bearing free deeply lobed tertiary leaflets which are dimorphous, sterile and fertile; upper surfaces of rachises and axes of leaflets raised, bearing rather stiff antrorse hairs, lower surfaces variously hairy; fertile leaflets more deeply lobed than sterile and with reduced lamina, each lobe bearing one sorus at the end of the vein or of the basal acroscopic branch if the vein is branched; *sori* each protected by a reflexed marginal lobe of the lamina and by a somewhat thinner inner indusium joined to the receptacle on its basiscopic side (fig. 31c); free surface of receptacle slightly elevated and distinctly elongated transverse to the end of the vein; *paraphyses* numerous, hair-like, multiseptate, each with a red-brown terminal cell; sporangia distinctly stalked, with complete oblique annulus indurated round the base, the stomium lateral; spores trilete, surfaces variously sculptured or almost smooth, exospore more or less thickened at the angles.

Type species: *Dicksonia arborescens* L'HÉRIT. (St Helena).

Distr. About 25 spp. St Helena; S. America and north to Mexico; New Zealand, E. Australia and Tasmania, New Caledonia, Samoa, Fiji; in *Malaysia*: New Guinea, Celebes, Philippines, N. Borneo, Java, and Sumatra.

Morph. The trunk of *Dicksonia* is closely similar in form and anatomy to that of *Cyathea*, from which *Dicksonia* differs by the indument consisting entirely of hairs. For comment on the possible relationships between the very different soral forms in the two genera, see p. 69.

Cytol. Chromosome counts have been made by BROWNLIE for two New Zealand species; both showed



$n = 65$  (New Phytol. 56, 1957, 207). MANTON found the same number for *D. arborescens* (type species of genus) in cultivation at Kew (J. Linn. Soc. Bot. 56, 1958, 84).

**Taxon.** The history of the varied use of the generic name *Dicksonia* is summarized by MAXON, *l.c.* Earlier authors confused not only *Dicksonia*, *Calcuta* and *Cibotium*, but also *Dennstaedtia* and other genera now recognized as distinct. Within the genus, the discrimination of species is difficult because the soral form is so constant and the variation in shape of tertiary leaflets as between those on larger or smaller pinnules in one species may be considerable. The character of the hairs on the stipe appears to be one of the clearest distinctions between species, as are scale-characters in *Cyathea*; but the differences between one hair and another are less easily defined than those between different scales. The species in New Guinea are particularly difficult to discriminate, and the present account can only be regarded as tentative; more field observation is needed.

## KEY TO THE SPECIES

1. Base of stipe clothed with dark red spreading hairs 30–50 mm long; hairs of under-coat pale, slender or flaccid, much shorter.
  2. Hairs of under-coat of stipe-base, and most hairs on lower surface of pinna-rachis and costae, pale, slender, rigid, spreading, not flaccid. Spores smooth . . . . . 1. *D. blumei*
  2. Hairs of under-coat of stipe-base, and smaller hairs on lower surface of pinna-rachis (in some cases also of costa) short, pale, flaccid, their lateral walls collapsed. Spores verrucose.
    3. Hairs on costae almost all flaccid, pale,  $\pm$  antrorse, matted . . . . . 2. *D. mollis*
    3. Hairs on costae mostly rigid, each cell evenly cylindrical.
      4. Hairs on costae: some flaccid, some spreading, mostly pale . . . . . 3. *D. sciurus*
      4. Hairs on costae ascending, mostly dark red . . . . . 4. *D. archboldii*
1. Base of stipe clothed mainly with soft matted red-brown hairs, with or without a smaller number of stout rigid dark red hairs.
  5. Some stout rigid spreading dark red hairs present near base of stipe, and scattered also on pinna-rachis; pinna-rachis mainly clothed with a close layer of pale matted flaccid hairs.
    5. *D. hieronymi*
  5. No stout rigid spreading dark red hairs mixed with softer hairs on stipe-base.
    6. Pinna-rachis rather dark and  $\pm$  glabrescent; costae bearing flaccid pale hairs  $\pm$  mixed with thicker dark hairs with pale bases . . . . . 6. *D. grandis*
    6. Pinna-rachis brown, persistently hairy beneath; costae bearing entirely pale flaccid hairs.
      7. *D. lanigera*

1. *Dicksonia blumei* (KUNZE) MOORE, Ind. Fil. (1860) 190; v. A. v. R. Handb. (1908) 47; BACKER & POSTH. Varenfl. Java (1939) 22.—*Balanium blumei* KUNZE, Bot. Zeit. 6 (1848) 214.—*Balanium chrysotrichum* HASSK. Obs. Fil. Jav. 1 (1856) 53.—*D. chrysotricha* MOORE, Ind. Fil. (1860) 190; Hook. & Bak. Syn. Fil. (1868) 50; RACIB. Fl. Btzig 1 (1898) 121; DIELS in E. & P. Pfl. Fam. 1, 4 (1899) 121; CHRIST, Ann. Jard. Bot. Btzig 19 (1904) 41.—**Fig. 31a–c.**

Trunk to 6 m; stipes to 60 cm or more, clothed at the base with spreading red-brown shining hairs 30–50 mm long, with an under-coat of much finer short pale hairs; upper part of stipe and main rachis dark, finely and closely warty, bearing sparse short pale hairs; lamina to 300 cm long; pinnae to 70 cm long, pinna-rachis bearing pale spreading hairs on lower surface, with a few red ones; pinnules to 100 by 15–20 mm; costules of tertiary leaflets 4 mm apart; largest fertile tertiary leaflets lobed throughout almost to the costule, with 4–5 pairs of soriferous lobes, the lowest lobes usually bilobulate with forked vein, sterile lobule not longer than fertile; largest sterile tertiary leaflets less deeply lobed, veins in lowest lobe pinnate, in rest forked or simple; hairs on lower

surface of costae and costules pale, firm (cell-walls not collapsed), spreading; spores almost smooth.

Type specimen: ZOLLINGER 1894, Java (B?; dupl. at P, L); also cited SPORLEDER, Java.

Distr. *Malaysia*: Sumatra (north to Karo Plateau), Java, Central Celebes (SARASIN 2030). Ecol. In mountain forest, 1500–2500 m.

2. *Dicksonia mollis* HOLTUM, Kew Bull. 16 (1962) 64.—*D. blumei* [non (KUNZE) MOORE] C. CHR. Gard. Bull. S.S. 7 (1934) 223; COPEL. Fern Fl. Philip. 1 (1958) 84.—**Fig. 31d–e.**

Differs from *D. blumei* as follows: hairs of under-coat on the stipe shorter, thicker, but flaccid with walls collapsed when dry; hairs on lower surface of pinna-rachis and costae more numerous, appressed, flaccid, mostly ascending; spores bearing conspicuous more or less coalescent warts.

Type specimen: ELMER 9874, Dumaguete (Cuernos Mts) Negros Oriental, Negros (K; dupl. at L, P, MICH, US).

Distr. *Malaysia*: NE. Borneo, Central Celebes (?), Philippines (Mindanao to S. Luzon).

Ecol. Mountain forests, 1500–2000 m. The Celebes specimen, much smaller than those from



Fig. 31. *Dicksonia blumei* (KUNZE) MOORE. a. Part of pinna, showing sterile and fertile pinnules,  $\times \frac{2}{3}$ , b. part of pinnule, lower surface, showing sori and rigid hairs,  $\times 6$ , c. section of sorus,  $\times 8$ .—*D. mollis* HOLTUM. d. Part of sterile pinnule, lower surface, showing flaccid hairs,  $\times 6$ , e. hairs from lower surface,  $\times 30$ .—*D. antarctica* LABILL. f. Section of stipe (hairs omitted),  $\times 2$ , g. section of pinna-rachis,  $\times 4$  (a DE VRIESE s.n., b–c MATTHEW s.n., d SINCLAIR 9005, e ELMER 9874, f–g cult. R. B. G. Kew).

Borneo and the Philippines, was found at 2900 m, in dry open vegetation (EYMA 959); it lacks a stipe. It agrees better with *D. mollis* than with New Guinea species (it is certainly not *D. blumei*), but without more complete material its status is doubtful.

**3. *Dicksonia sciurus* C. CHR.** *Brittonia* 2 (1937) 283; COPEL. *Philip. J. Sc.* 78 (1949) 6.

*Stipe* 35 cm, the base covered with spreading red-brown hairs 25–40 mm long, with an undercoat of short pale flaccid hairs; upper part of stipe and lower surface of main rachis more sparsely clothed with similar but shorter red-brown hairs and short flaccid pale ones; longest *pinnæ* 60 cm long, rachis dark brown, its lower surface bearing rather sparse spreading reddish hairs and a more or less abraded cover of short flaccid pale hairs;

*pinnules* to 150 mm long (on type not over 80 mm), costules of tertiary leaflets 4–5 mm apart, hairs on lower surface of costae and costules mostly pale, some flaccid and some spreading; *tertiary leaflets* to 20 mm long, fertile ones lobed almost to costule, basal lobes of largest fertile leaflets having a bluntly-toothed sterile lobule exceeding the fertile one, sterile tertiary leaflets less deeply lobed than fertile, lobes mostly with pinnately arranged veins and bluntly toothed edges.

Type specimen: BRASS 4991, Mt Tafa, Papua (BM; dupl. at BO, MICH, BRI, UC).

Distr. *Malaysia*: E. New Guinea (several collections).

Ecol. Plentiful in ridge forest, at 1800–2400 m.

**4. *Dicksonia archboldii* COPEL.** *Philip. J. Sc.* 78 (1949) 6, pl. 1.

*Stipe* 30–40 cm, base clothed with spreading rather soft red-brown hairs 25 mm or more long, with short flaccid pale hairs also; leafy part of frond to c. 300 cm long; lower *pinnæ* gradually reduced, lowest 15 cm long, longest 65 cm, pinna-rachis beneath dark, clothed rather sparsely with dark red rigid hairs, the smallest ones with a pale inflated basal cell, also short pale flaccid hairs; *pinnules* to 140 mm long, costa covered beneath with rigid flexuous antrorse dark red hairs, some with a pale base, and on distal part a few pale flaccid ones; costules of tertiary leaflets 5–6 mm apart; sterile *tertiary leaflets* to 20 mm long, lobed to costule at base, lobes to 6 pairs, veins pinnate in each, edges toothed; fertile tertiary leaflets lobed throughout to costule, lobes to 5 pairs, each with a sorus, the basal ones also with an acute sterile tooth.

Type specimen: BRASS 10970, Lake Habbema, 2750 m, near Mt Wilhelm, W. New Guinea (MICH; dupl. at L).

Distr. *Malaysia*: West New Guinea, only known from the type collection and a much smaller one from Mt Arfak, Anggi Lakes (SLEUMER & VINK BW 14193).

Ecol. "Abundant in forest of lower slopes, stem 4 m high, 13 cm  $\phi$  under the leaves and thickened downwards; leaves 10, spreading".

Note. This is near *D. sciurus* C. CHR. (an earlier name) and the two should perhaps be united. The type of *D. archboldii* is larger than that of *D. sciurus* in all parts of the frond, and the hairs on the costae are mostly red and ascending; the fertile tertiary leaflets of *D. sciurus* have in some cases a larger sterile portion, but this varies according to position on the frond, and whole fronds of each type are not available for comparison.

5. *Dicksonia hieronymi* BRAUSE, Bot. Jahrb. 56 (1926) 48; C. CHR. Brittonia 2 (1937) 282; COPEL. Philip. J. Sc. 78 (1949) 6.

*Stipe* 20–30 cm, covered near the base with soft dull brown matted hairs with a few longer rigid shining dark red-brown ones; upper part of stipe and main rachis dark, rather persistently covered with appressed soft brown matted hairs with a few rigid shining ones; largest *pinnæ* 30–60 cm long; pinna-rachis dark brown, hairy on under surface as main rachis; largest *pinnules* 70–120 mm long, costa pale distally, dark near base, covered beneath with flaccid  $\pm$  appressed light brown hairs, some with rigid dark apical portion; largest *tertiary leaflets* 10–20 mm long, fertile lobed to the costule, fertile lobes 3–5 pairs, the larger with forked vein and a sterile lobule which is rarely larger than the fertile one; sterile tertiary leaflets deeply lobed at base, less deeply upwards, larger lobes containing pinnately branched veins, edges of lobes almost entire.

Type specimen: LEDERMANN 12851, Sepik region, 1400–1500 m, E. New Guinea (B).

Distr. *Malaysia*: New Guinea (several localities) including Louisiade Arch.

Ecol. In mossy forest, at 1400–3000 m; fronds usually few.

6. *Dicksonia grandis* ROSENST. in Fedde, Rep. 5 (1908) 34; COPEL. Philip. J. Sc. 78 (1949) 5.—*D. schlechteri* BRAUSE, Bot. Jahrb. 49 (1912) 11; COPEL. Philip. J. Sc. 78 (1949) 6.—*D. ledermannii* BRAUSE, Bot. Jahrb. 56 (1920) 46; COPEL. Philip. J. Sc. 78 (1949) 5.

*Stipe* at least 30 cm, nearly black, lower part covered with fine soft light brown hairs, longest 25 mm, all of same texture; *pinnæ* to 100 cm long, pinna-rachis beneath very dark, minutely warty, more or less glabrescent, with vestiges of short appressed hairs which are mostly lax and pale brown, with some firm and reddish (the latter sometimes with pale bases); *pinnules* to 140 mm long, costa hairy beneath as pinna-rachis, dark at base and paler distally; *tertiary leaflets* to 20 mm long, fertile ones deeply lobed, lobes to 5 pairs, each lobe of largest leaflets with a pinnate vein bearing a sorus on its basal acroscopic branch, of smaller leaflets sometimes with simple vein bearing a sorus; sterile tertiary leaflets lobed almost to costule at base, less deeply upwards, each lobe of larger ones containing a pinnately branched vein, edges of lobes almost entire.

Type specimen: WERNER 79, in forest, 1000 m, Mt Gelu, E. New Guinea (also distributed as ROSENST. Fil. Novoguine. exsic. n. 50 (B; dupl. at L, P, US, UC).

Distr. *Malaysia*: New Guinea (several localities).

Ecol. In forest, most specimens at 1000–1800 m; one (PULLE 939, Mt Hellwig) from 2500 m, a small plant but agreeing in hairiness.

7. *Dicksonia lanigera* HOLTUM, Kew Bull. 16 (1962) 64.

*Stipe* to at least 30 cm, densely hairy throughout, hairs uniform, soft, medium brown, to 15 mm, the shorter hairs of same texture, no thick firm red hairs present; *lamina* c. 150 cm long; *rachis* beneath red-brown when dry, covered with matted short hairs like those of the stipe; *pinnæ* to 40 cm long, pinna-rachis persistently hairy as rachis on lower surface; largest *pinnules* 80 mm long, costules  $5\frac{1}{2}$  mm apart; costa beneath brown-hairy almost to apex; *tertiary leaflets* to 15 mm long, sterile ones deeply lobed near the base and less deeply upwards, larger lobes each with a pinnate vein, edges toothed; fertile tertiary leaflets deeply lobed throughout, vein in larger lobes forked, acroscopic branch bearing a sorus, sterile part of lobe not longer than fertile.

Type specimen: PULLE 1010, Mt Wichman, 3000 m, SW. New Guinea (L; dupl. at BM).

Distr. *Malaysia*: W. & E. New Guinea.

Ecol. In forest, at 2500–3000 m.

Excluded from *Dicksonia*

*Dicksonia ampla* BAK. J. Linn. Soc. Bot. 22 (1886) 223 = *Dennstaedtia ampla* (BAK.) BEDD.

*Dicksonia cuneata* HOOK. Sp. Fil. 1 (1844) 80 = *Dennstaedtia cuneata* (HOOK.) MOORE.

*Dicksonia deltoidea* HOOK. Sp. Fil. 1 (1844) 80 = *Dennstaedtia scabra* (WALL.) MOORE.

*Dicksonia erythrorachis* CHRIST, Ann. Jard. Bot. Btzg 15 (1897) 86 = *Dennstaedtia erythrorachis* (CHRIST) DIELS.

*Dicksonia flaccida* (FORST.) SW. in Schrader, J. Bot. 1800, ii (1801) 90 = *Dennstaedtia flaccida* (FORST.) BERNH.

*Dicksonia glabrata* CES. Rend. Ac. Napoli 16 (1877) 24, 28 = *Dennstaedtia glabrata* (CES.) C. CHR.

*Dicksonia gomphophylla* BAK. J. Linn. Soc. Bot. 22 (1886) 223 = *Dennstaedtia gomphophylla* (BAK.) C. CHR.

*Dicksonia japonica* SW. in Schrader, J. Bot. 1800, ii (1801) 92 = *Microlepia strigosa* (THUNB.) PRESL.

*Dicksonia kingii* BEDD. Handb. Suppl. (1892) 6 = *Orthiopteris kingii* (BEDD.) HOLTUM.

*Dicksonia linearis* CAV. Descr. (1802) 274 = *Tapeinidium pinnatum* (CAV.) C. CHR.

*Dicksonia moluccana* BL. En. Pl. Jav. (1828) 239 = *Dennstaedtia moluccana* (BL.) MOORE.

*Dicksonia neglecta* FÉE, Gen. Fil. (1850–52) 335 = *Dennstaedtia smithii* (HOOK.) MOORE.

*Dicksonia nephrolepioides* CHRIST, Verh. Nat. Ges. Basel 11 (1895) 241 = *Nephrolepis dicksonioides* CHRIST.

*Dicksonia remota* CHRIST, Verh. Nat. Ges. Basel 11 (1896) 423 = *Dennstaedtia remota* (CHRIST) DIELS.

*Dicksonia rhombifolia* BAK. J. Bot. 28 (1890) 105 = *Dennstaedtia rhombifolia* (BAK.) C. CHR.

*Dicksonia scabra* WALL. ex HOOK. Sp. Fil. 1 (1844) 80 = *Dennstaedtia scabra* (WALL.) MOORE.

*Dicksonia scandens* BL. En. Pl. Jav. (1828) 240 = *Dennstaedtia scandens* (BL.) MOORE.

*Dicksonia smithii* HOOK. Sp. Fil. 1 (1844) 80 = *Dennstaedtia smithii* (HOOK.) MOORE.

*Dicksonia strigosa* THUNB. Trans. Linn. Soc. 2 (1794) 341 = *Microlepia strigosa* (THUNB.) PRESL.

*Dicksonia zippeliana* KUNZE, Bot. Zeit. 3 (1845) 838 = *Dennstaedtia scandens* (BL.) MOORE.

### 3. CYSTODIUM

J. SM. in Hook. Gen. Fil. (1841) t. 96; Hist. Fil. (1875) 258.—**Fig. 32.**

*Stem* massive, usually creeping, covered with long hairs. Fronds tufted, bipinnate; stipe grooved on adaxial surface, vascular tissue arranged as in *Dicksonia*; upper surface of *pinna*-rachis antrorsely hairy and grooved, the groove not open to admit the grooves of midribs of pinnules; pinnules slightly dimorphous, sterile ones serrate, fertile ones with slightly narrower lamina and teeth enlarged to protect sori; veins in pinnules pinnately arranged, oblique, often forked in larger pinnules, simple in smaller ones except for the basal pair which may be pinnate; *sori* terminal on veins, receptacle slightly raised, round in section, tooth of lamina reflexed and enlarged, forming an outer indusium, inner indusium smaller and thinner, attached only at the base of the sorus; *paraphyses* abundant, as simple multiseptate hairs lacking a terminal glandular cell; *sporangia* stalked, stalk as long as body of the sporangium, annulus complete and slightly oblique but not indurated at base where it passes the stalk; spores trilete.

Distr. Monotypic, *Malaysia*: from NE. Borneo to New Britain & Louisiades.

Notes. The single species agrees with *Dicksonia* in hairs and their distribution, in arrangement of vascular tissue in the frond, and in form of sori; it differs from *Dicksonia* (1) in normally prostrate position of stem, (2) in grooved upper surface of rachis, pinna-rachis and costules, (3) in shape of pinnules, which are crenate or serrate (not deeply lobed as in *Dicksonia*), (4) in circular transverse section of receptacle of sorus, (5) in smaller sporangia on longer stalks, and (6) almost vertical annulus, not indurated at the base.

JOHN SMITH (*l.c.* 1875) stated that the pinnules are jointed to the rachis (a character to which he attached great importance), but they are not so.

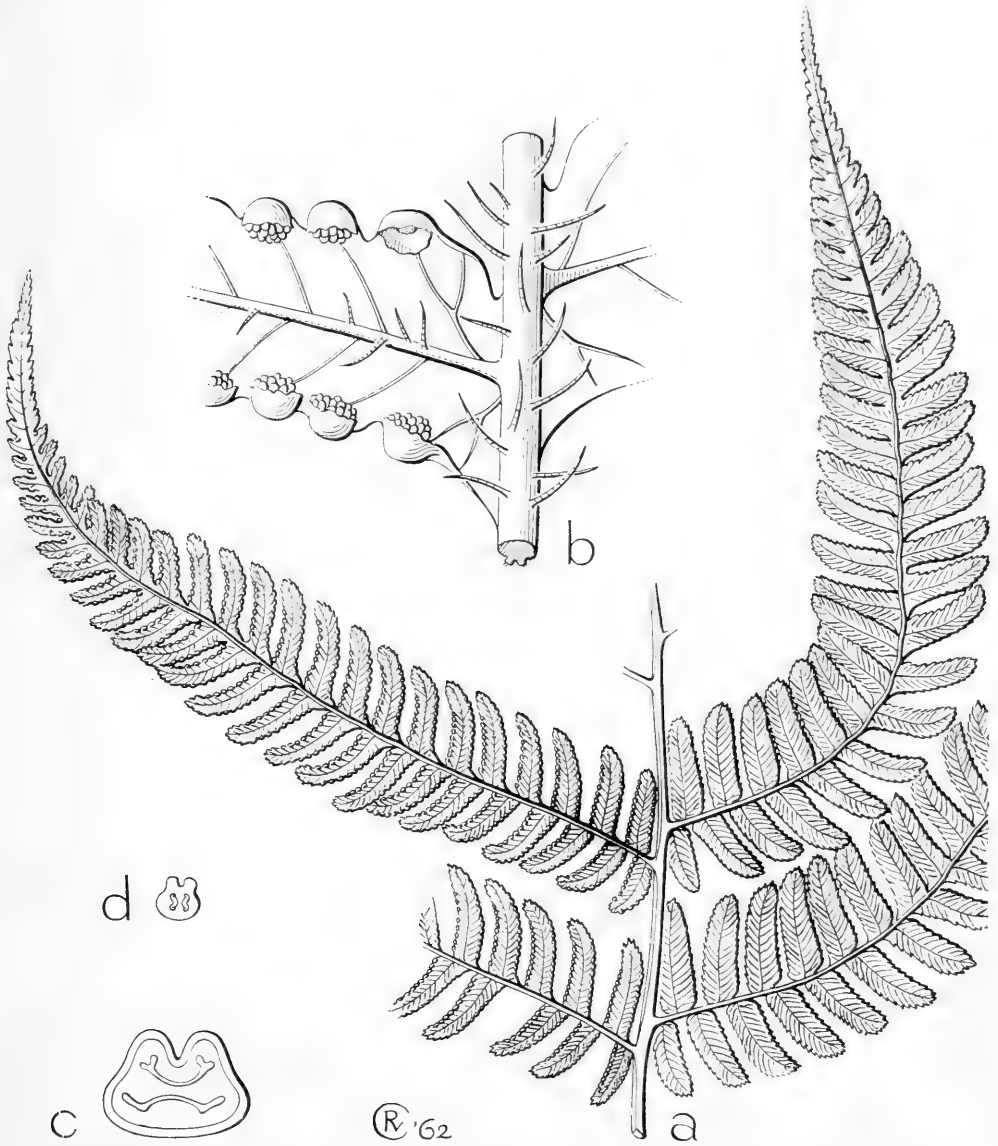


Fig. 32. *Cystodium sorbifolium* (SM.) J. SM. *a*. Middle part of rachis with pinnae,  $\times \frac{2}{3}$ , *b*. lower surface of part of pinna, near its base; sporangia removed from one sorus to show inner indusium,  $\times 6$ , *c*. section of stipe,  $\times 4$ , *d*. section of pinna-rachis,  $\times 4$  (C. HOSE 217).

1. *Cystodium sorbifolium* (SM.) J. SM. in Hook. Gen. Fil. (1841) t. 96; COPEL. Sarawak Mus. J. 2 (1917) 344; C. CHR. Gard. Bull. S.S. 7 (1934) 239; Ind. Fil. Suppl. 3 (1934) 66; COPEL. Philip. J. Sc. 78 (1950) 7.—*Dicksonia sorbifolia* SM. in Rees, Cyclop. 11 (1808) n.p.; HOOK. Sp. Fil. 1 (1844) 72, t. 25A; HOOK. & BAK. Syn. Fil. (1868) 52; CHRIST, Ann. Jard. Bot. Btzig 15 (1898) 87; V. A. v. R. Handb. Suppl. (1917) 74.—*Dicksonia*

*moluccana* ROXB. Calc. J. Nat. Hist. 4 (1844) 517.—*Dicksonia papuana* F. v. M. Descr. Not. 4 (1876) 76; COPEL. Philip. J. Sc. 6 (1911) Bot. 69.—*Saccoloma sorbifolia* CHRIST, Farnkr. Erde (1897) 309; C. CHR. Ind. Fil. (1905) 612; V. A. v. R. Handb. (1908) 282.—Fig. 32.

*Stem* usually creeping (once reported erect,  $\frac{1}{2}$  m high), densely covered like the bases of the stipes with soft golden brown shining hairs c. 3 cm

long. *Stipes* to 75 cm, glabrescent and smooth above the base; *lamina* 100–250 cm long, lowest pinnae not greatly reduced; *largest pinnae* 20–30 by 5–9 cm, bearing free pinnules for  $\frac{1}{2}$ – $\frac{2}{3}$  of their length, apical part deeply lobed; sterile *pinnules* 6–8 mm wide, fertile 5–6 mm wide, separated by gaps of c. 2 mm; pinnules slightly oblique, their costules falcate, asymmetric at the base (rounded to cordate on basiscopic side, broadly truncate and sometimes auricled on acroscopic side), edges almost parallel except towards apex; lower surface of pinna-rachis, costules of pinnae and sometimes veins bearing more or less

abundant spreading hairs 1 mm long. *Sori*  $1\frac{1}{2}$ –2 mm apart, at ends of all veins on fertile pinnules (on acroscopic branch if vein is forked). *Spores* bearing on their surface a fine irregular slightly raised reticulum.

Type specimen: C. SMITH, Honimoo, Ceram (Herb. J. E. Smith; dupl. at K).

Distr. *Malaysia*: N. Borneo, N. Celebes, Moluccas (Ceram), New Guinea (incl. New Britain, Admiralty Is and Louisiade Arch.).

Ecol. In lowland forest, to 400 m, often near rivers.

#### 4. CIBOTIUM

KAULFUSS, Berl. Jahrb. Pharm. 21 (1820) 53; En. Fil. Chamisso (1824) 229; PRESL, Tent. Pterid. (1836) 67, *excl. syn. Deparia*; HOOK. Gen. Fil. (1839) t. 25; Sp. Fil. 1 (1844) 82; DIELS in E. & P. Pfl. Fam. 1, 4 (1899) 121; C. CHR. Ind. Fil. (1905) xvi, 183; MAXON, Contr. U. S. Nat. Herb. 16 (1912) 54; COPEL. Gen. Fil. (1947) 49.—*Pinonia* GAUDICH. Ann. Sc. Nat. 3 (1824) 507.—*Dicksonia* § *Cibotium* HOOK. & BAK. Syn. Fil. (1868) 49.—**Fig. 33.**

*Caudex* massive, erect or prostrate (Malaysian species mostly the latter), the apex protected by a thick cover of long slender hairs. *Stipes* always long, smooth, covered with hairs at the base or throughout. *Fronds* large, bipinnate, lowest pinnae not greatly reduced, all axes more or less hairy, or in some cases glabrescent; *pinnules* deeply pinnatifid throughout, the lowest lobes sometimes free as tertiary leaflets, lobes each with a costule bearing simple or forked lateral veins; costae of pinnules raised (not grooved) on upper surface; fertile pinnules not different in shape or size from sterile. *Sori* at the ends of veins, protected by two indusia which are alike in texture and different from the green lamina of the lobes on which they are borne, the outer indusium deflexed so that the sorus appears to be on the under side of the lobe, the inner indusium at maturity bending back towards the costule and elongating, usually becoming oblong, the two indusia joined together for a short distance at the base, thus forming a small cup round the receptacle of the sorus; receptacle somewhat prominent, elongate obliquely to the end of the vein which bears it, bearing numerous sporangia and long paraphyses; sporangia similar to those of *Dicksonia*; spores trilete, bearing few strongly raised ridges on the outer surface.

Type species: *Cibotium chamissoi* KAULF., Hawaii.

Distr. About 12 *spp.*, distributed in Central America and Mexico, Hawaii, Assam to southern China, southwards to Western Malaysia and Philippines.

#### KEY TO THE SPECIES

1. *Sori* 2 or more pairs on each pinnule-lobe of larger fronds. Largest pinnules 20–35 mm wide; pinnules on the two sides of a pinna not greatly different in length. Hairs on lower surface of costae and costules almost always thin and flaccid, never spreading . . . . . 1. *C. barometz*
1. *Sori* never more than 2 pairs on each pinnule-lobe. Largest pinnules 15–25 mm wide; pinnules on basiscopic side of lower pinnae much shorter than those on acroscopic side. Some rigid hairs usually present with flaccid ones on lower surface of costae, the rigid hairs sometimes spreading.
2. Always one pair of *sori*. Spreading hairs usually present on lower surface of costae; hairs normally absent on lower surface of lamina between veins . . . . . 2. *C. cumingii*
2. Always two pairs of *sori* on large fronds. Spreading hairs lacking, but rigid (often red) appressed hairs always present and sometimes abundant; small flaccid hairs present on lower surface of lamina between veins . . . . . 3. *C. arachnoideum*

1. *Cibotium barometz* (L.) J. Sm. Lond. J. Bot. 1 (1842) 437; BEDD. Handb. (1883) 24; Suppl. (1892) 6; DIELS in E. & P. Pfl. Fam. 1, 4 (1899) 121; CHRIST, Philip. J. Sc. 2 (1907) Bot. 117, incl. var. *sumatranum* CHRIST, l.c. 118; v. A. v. R. Handb. (1908) 48, 792, p.p.; Suppl. (1917) 77; HEYNE, Nutt. Pl. (1927) 103; BURK. Dict. (1935) 536; BACKER & POSTH. Varenfl. Java (1938) 23, f. 7; TARD.-BLOT & C. CHR. Fl. Gén. I.-C. 7, 2 (1939) 78, f. 10; HOLTUM, Rev. Fl. Mal. 2 (1954) 114, f. 45; A. F. TRYON, Miss. Bot. Gard. Bull. 43 (1955) n. 2; Am. Fern J. 47 (1957) 1; CHING, Fl. Rep. Pop. Sin. 2 (1959) 197.—*Polypodium barometz* LINNÉ, Sp. Pl. (1753) 1092; LOUR. Fl. Coch. (1790) 675.—*Aspidium barometz* WILLD. Sp. Pl. 5 (1810) 268.—*Balanium glaucescens* LINK, Fil. Sp. Hort. Berol. (1841) 40.—*Dicksonia baranetz* LINK, l.c. 166; HOOK. & BAK. Syn. Fil. (1868) 49 (*barometz*).—*C. glaucescens* KUNZE, Farrnkr. 1 (1841) 63, t. 31; HOOK. Sp. Fil. 1 (1844) 82.—*C. assamicum* HOOK. Sp. Fil. 1 (1844) 83, t. 29B; CHRIST, Philip. J. Sc. 2 (1907) Bot. 117.—*Dicksonia assamicum* GRIFF. Notul. 2 (1849) 607; l.c. Pl. As. 2 (1849) t. 136, f. 2.—*C. djambia-*

*num* HASSK. Obs. Fil. Jav. 1 (1856) 61.—*C. glaucum* [non (SM.) HOOK. & ARN.] BEDD. Ferns Br. Ind. (1865) t. 83.—Fig. 33a-c.

*Caudex* usually prostrate; hairs near apex shining, brown, to 4 cm or more long. *Stipes* to at least 120 cm, base densely hairy, rest smooth when old, softly short-hairy when young. *Lamina* to 200 cm long; longest pinnae 80 cm long. Largest *pinnules* 150 by 20–35 mm, lobed almost to the costa, often with 1–2 pairs of free tertiary leaflets at the base; costules  $3\frac{1}{2}$ – $4\frac{1}{2}$  mm apart; segments of lamina glaucous beneath, edges where sterile crenate-serrate; lower surface of costae and costules more or less densely covered with pale entangled flaccid appressed hairs (young plants softly hairy throughout); veins oblique, usually forked, in largest pinnules sometimes twice forked. *Sori* 2–4 or more pairs on largest fronds, at the ends of lower veins on each lobe of the lamina, soriferous veins usually unbranched; receptacle rather oblique to the end of the vein so that it is parallel to the edge of the lobe; outer indusium permanently round, inner elongating at maturity and more or less oblong.

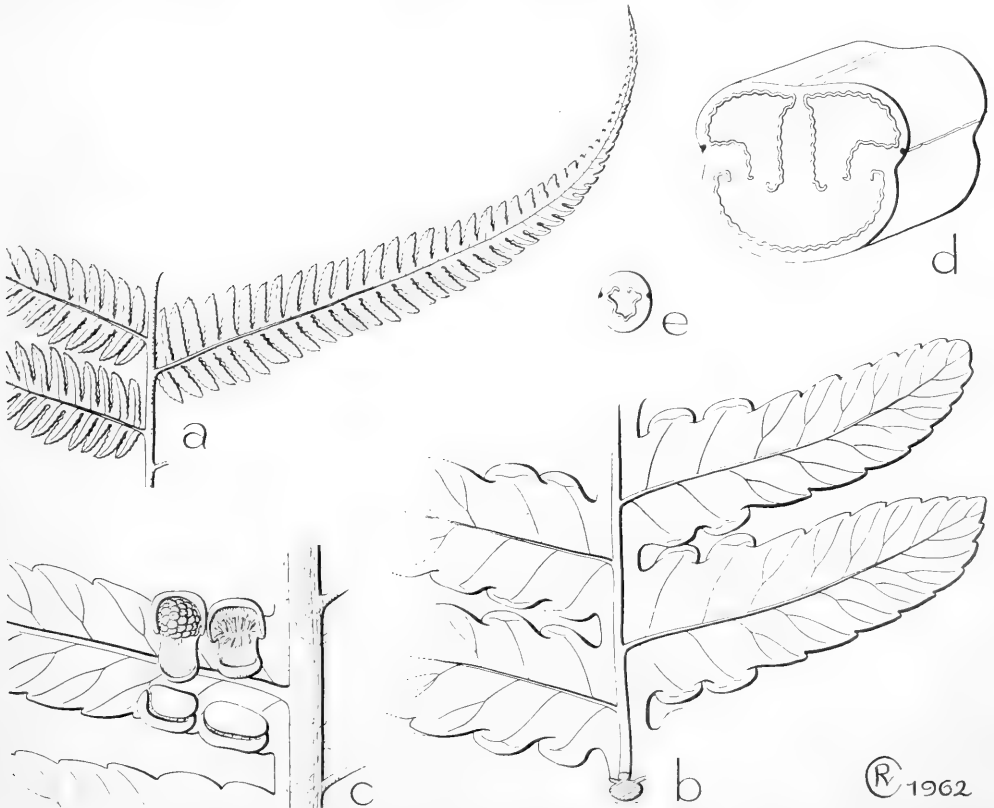


Fig. 33. *Cibotium barometz* (L.) J. Sm. a. Part of pinna-rachis with pinnules,  $\times \frac{2}{3}$ , b. part of pinnule, upper surface, showing venation (unbranched basal veins lead to sori)  $\times 6$ , c. part of pinnule, lower surface, showing sori; 2 sori covered by indusia, 2 with inner indusium reflexed and extended,  $\times 6$ .—*C. regale* LINDEN. d. Section of stipe, nat. size, e. section of pinna-rachis, nat. size (a-c CURTIS 3103, d-e cult. R. B. G. Kew).

Type specimen: none in Linnean Herbarium. LINNAEUS stated that he had a specimen from China, and the identity is not in doubt.

Distr. NE. India to S. China and Formosa, southwards to Malaysia, in *Malaysia*: Sumatra, Malay Peninsula, and Java.

Ecol. Amongst non-calcareous rocks and on steep ground in mountain forest, from near sea-level to 1600 m, in the Malay Peninsula and Sumatra; in Java only known from Mt Slamet at 1600 m. I have seen young plants of this species growing on a bare earth bank in a rather open place, above a path recently cut through forest on a mountain slope; perhaps in nature the species chiefly spreads by the establishment of new plants on land-slides. A specimen from Fraser's Hill (E. SMITH 802) bears the note "frond 4 m, [incl.] stipe 2 m". Young plants are soft-hairy all over.

Note. The name *barometz* was derived from the story of the vegetable lamb of Tartary (see A. F. TRYON, *l.c.*); but whatever plant gave rise to the strange fable of the vegetable lamb, it was not *Cibotium*. LINK, KUNZE, and some later botanists have noted that *baranetz* (from the Russian *baran*, a lamb; *baranets*, a diminutive form) is a more correct spelling of the name of the vegetable lamb than *barometz*; but the latter spelling was that adopted by LINNAEUS.

Uses. The hairs on the rhizome of this species of *Cibotium* (probably also of other species) have long been used in China as a styptic for bleeding wounds, and they have also been so used by various peoples in Malaysia; for details, see HEYNE and BURKILL. The common trade-name for these hairs seems to be *Pĕnawar* (*Djambi*). *Cibotium* hairs have also been used for stuffing cushions and for upholstery, but it is reported that they are not very satisfactory for this purpose.

2. *Cibotium cumingii* KUNZE, Farnkr. 1 (1841) 64, 65; CHRIST, Philip. J. Sc. 2 (1907) Bot. 118; COPEL. Fern Fl. Philip. 1 (1958) 84.—*C. glaucum*

[*non* (SM.) HOOK. & ARN.] J. SM. in Hook. J. Bot. 3 (1841) 418.—*C. baranetz* var. *cumingii* v. A. v. R. Handb. Suppl. (1917) 77.—*C. crassinerve* ROSENST. Med. Rijksherb. n. 31 (1917) 4.

Habit as in *C. barometz*, but fronds probably never quite so large; pinnules to 180 mm long, rarely over 20 mm wide, those on basiscopic side towards base of a pinna much shorter than those on acroscopic side (often less than half as long), distal pinnules and those of upper pinnae more equal; sori always one pair at the base of each fertile segment of a pinnule; hairiness of lower surface of costae and costules variable, usually some stiff spreading hairs (pale or reddish) present along with appressed flaccid hairs, in some cases either the one or the other kind predominating.

Type specimen: CUMING 123, Luzon (K; dupl. at P, US).

Distr. *Malaysia*: Philippines (Luzon, Mindoro, Mindanao).

3. *Cibotium arachnoideum* (C. CHR.) HOLTUM, comb. nov.—*C. cumingii* var. *arachnoideum* C. CHR. Gard. Bull. S.S. 7 (1934) 224.

Like *C. cumingii* in asymmetry of the pinnae, but larger; pinnules to 200 by 25 mm; sori one or two pairs to each lamina-segment; many appressed antrorse hairs on lower surface of costae, some of them rigid and usually reddish but never spreading; pale flaccid hairs also on costules and veins, and often on the surface of the lamina between veins.

Type specimen: HOLTUM 25378, Mt Kinabalu, N. Borneo (K; dupl. at BM, SING).

Distr. *Malaysia*: Central and South Sumatra, Sarawak, and N. Borneo.

Ecol. On Mt Kinabalu abundant in secondary forest at c. 1000 m, on steep slopes which are periodically cleared by burning for cultivation, apparently surviving the burning; fronds were reported as up to 4 or 5 m in total height. Sumatran specimens were found at 1200–2000 m.

## 5. CULCITA

PRESL, Tent. Pterid. (1836) 135; HOOK. Gen. Fil. (1840) t. 60A; MAXON, J. Wash. Ac. Sc. 12 (1922) 454; C. CHR. Ind. Fil. Suppl. 3 (1934) 5, 57; COPEL. Gen. Fil. (1947) 49.—*Balantium* KAULF. En. Fil. (1824) 228, *p.p.*; J. SM. Hist. Fil. (1875) 257; DIELS in E. & P. Pfl. Fam. 1, 4 (1899) 119; C. CHR. Ind. Fil. (1905) xvi, 148; COPEL. Philip. J. Sc. 3 (1908) Bot. 301.—*Dicksonia* subg. *Balantium* HOOK. Sp. Fil. 1 (1844) 66, *p.p.*—*Dicksonia* § *Eudicksonia* HOOK. & BAK. Syn. Fil. (1868) 50, *p.p.*—**Fig. 34.**

*Caudex* massive, prostrate or erect, the young parts covered with hairs. *Stipes* long in proportion to lamina, more or less hairy throughout; pneumathodes prominent and separate (*subg. Culcita*) or forming a not quite continuous line along each side (*subg. Calochlaena*, fig. 34d). *Lamina* of large fronds quadripinnate, deltoid, pinnae and pinnules also deltoid, all branches of the frond asymmetric at the base, acroscopic sub-branch longer and at a broader angle than basiscopic; all axes and midribs of leaflets grooved on adaxial surface, the groove on a



larger axis open to admit grooves of smaller ones borne upon it (fig. 34c). *Sori* at the ends of veins, receptacle elongate at right angles to the vein-end, protected by a small reflexed lobe of the lamina (the outer indusium) and by a thinner inner indusium attached to the base of the receptacle; sporangia about as in *Dicksonia*, accompanied by many hair-like paraphyses; spores trilete, outer surface verrucose (Malaysian species).

Type species: *Culcita macrocarpa* PRESL (based on *Dicksonia culcita* L'HÉRIT.).

Distr. *Subg. Culcita*: Madeira and Azores, tropical America. *Subg. Calochlaena*: Australia, New Caledonia, New Hebrides, Fiji, Samoa, Solomon Islands, Malaysia; in *Malaysia*: Java, Lesser Sunda Is, Borneo, N. Celebes, Philippines, New Guinea. The species *C. formosae* (CHR.) MAXON, of Formosa, appears to be a *Dennstaedtia*, as originally placed by CHRIST.

Nomencl. The genus *Balantium* KAULF. was founded on two species, *B. auricomum* (a synonym of *Dicksonia arborescens*, type species of *Dicksonia*) and *B. culcita*. The description was almost entirely based on the former, which was figured, and the *sori* of the latter were not seen by KAULFUSS. MAXON (l.c. 1922) therefore argued that *Balantium* KAULF. should be typified by *B. auricomum* and so regarded as a synonym of *Dicksonia*. The generic distinction between the two species of KAULFUSS was recognized by PRESL, who founded a new genus *Culcita* for *B. culcita*, but left *B. auricomum* in *Balantium*, which he construed almost as we now construe *Dicksonia*; under *Dicksonia* he placed mostly species now included in *Dennstaedtia*.

Taxon. The genus *Culcita*, as first fully assembled by MAXON, consists of two distinct parts, *subg. Culcita* and *subg. Calochlaena* MAXON. The former includes only two very closely related species, *C. macrocarpa* PR. and *C. conifolia* (HOOK.) MAXON; *subg. Calochlaena* includes several species in a quite different geographic area which includes part of Malaysia. The species of this subgenus have much smaller *sori* than those of *subg. Culcita*, and were not regarded as part of the genus until DIELS (1899) included *C. straminea* (LABILL.) and COPELAND (1908, 1909) *C. dubia* (R. BR.) (fig. 34d-e) and *C. javanica* (BL.) in it under the name of *Balantium*. JOHN SMITH (1875), who recognized *Balantium* as distinct from *Dicksonia*, had placed *C. straminea* in *Dennstaedtia*. *C. dubia* remained doubtfully in its original genus *Davallia*, and *C. javanica* doubtfully in *Dennstaedtia*, in CHRISTENSEN's Index Filicum (1905).

The genus *Culcita* differs strikingly from *Dicksonia* in the shape of the frond, which always has a long stipe and is more finely divided, with all major parts triangular in outline and asymmetric at the base. It differs also from *Dicksonia* in the grooves of the upper surface of all axes, including midribs of leaflets, being open to receive grooves of minor axes. In both these characters, *Culcita* agrees with *Thyrsopteris*. The difference in rachis-characters between *Dicksonia* and *Culcita* is exactly that between *Ctenitis* and *Dryopteris*.

*Culcita* differs from *Dennstaedtia* in its more massive rhizome which is sometimes erect and when creeping has a radially symmetrical vascular system (dorsiventral in *Dennstaedtia*) with overlapping leaf-gaps; also in the inner indusium not being appreciably joined to the outer along its sides (the two are partly or almost wholly united in *Dennstaedtia*, forming a cup or funnel) but joined to the receptacle of the sorus on its basiscopic side as in *Dicksonia* (the receptacle is free or columnar in *Dennstaedtia*). As regards rachis-characters, species like both *Dicksonia* and *Culcita* are at present placed in *Dennstaedtia* (see TRYON, Contr. Gray Herb. n. 187, 1960, who makes this distinction the main division in his key to American species of *Dennstaedtia*).

*Subg. Calochlaena*, to which Malaysian species belong, might possibly rank as a separate genus, but it appears to be much more nearly related to *subg. Culcita* than to any other ferns. Apart from size of sorus, *subg. Culcita* differs from *subg. Calochlaena* in the shape and size of pneumathodes, and in the shape of the vascular strands as seen in transverse section near the base of the stipe; in the latter character *subg. Calochlaena* conforms closely to the general scheme of *Dicksonia* and *Cyathea*, whereas in *subg. Culcita* the vascular strands on the adaxial side diverge instead of converging and curving inwards.

Cytol. MANTON reported  $n = 66-68$  for *C. macrocarpa* (J. Linn. Soc. Bot. 56, 1958, 84), and has found  $n =$  approx. 55 for *C. dubia* in cultivation at Kew (unpublished).

#### KEY TO THE SPECIES

1. Inner indusium smaller than outer; midribs of quaternary leaflets rather closely hairy on lower surface. Mountain plants.
  2. Largest quinary lobes commonly with only one sorus. . . . . 1. *C. javanica*
  2. Largest quinary lobes commonly with 3 or 2 sori . . . . . 2. *C. villosa*
1. Inner indusium at maturity larger than outer, pouch-shaped and not reflexed; midribs of quaternary leaflets sparsely hairy. Lowland plants . . . . . 3. *C. straminea*

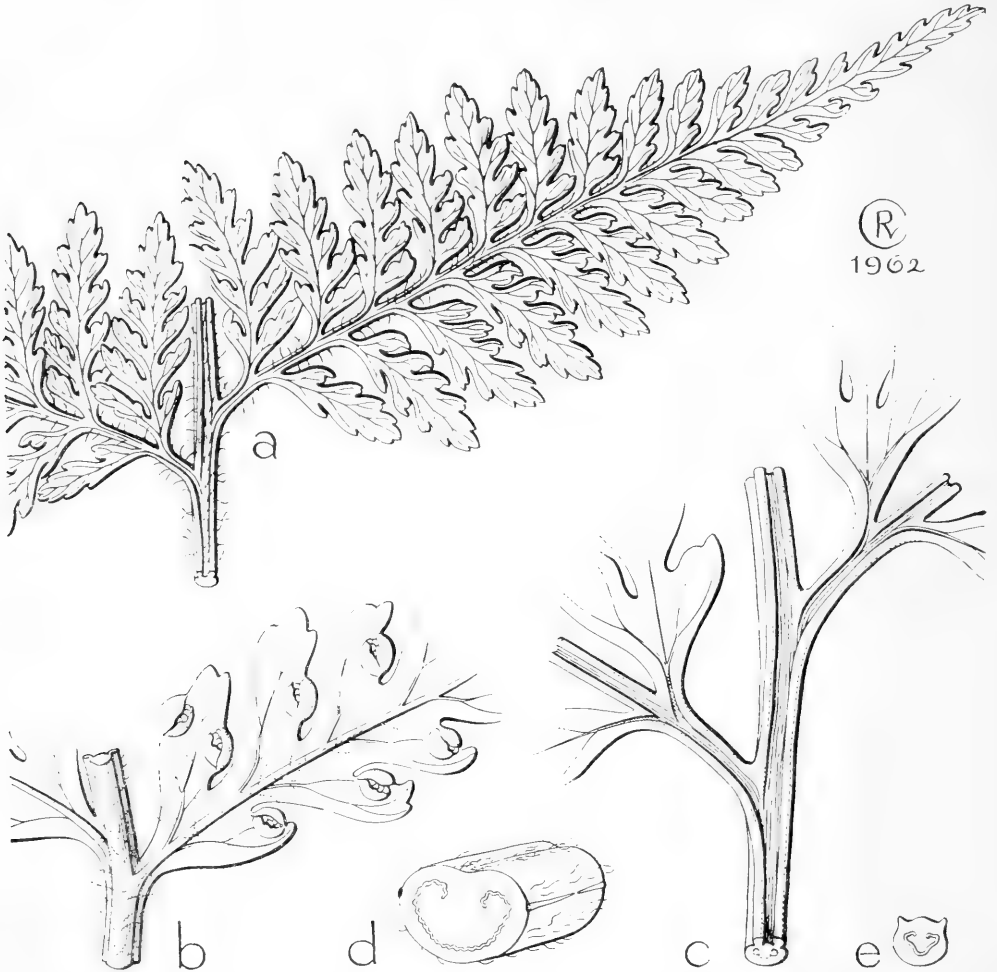


Fig. 34. *Culcita javanica* (BL.) MAXON. *a.* Part of pinna-rachis and complete pinnule, upper surface,  $\times 2$ , *b.* lower surface of leaflet showing sori, *c.* upper surface of part of pinnule, showing shape of rachis-branches,  $\times 6$ .—*C. dubia* (R. BR.) MAXON. *d.* Section of stipe,  $\times 2$ , *e.* section of pinna-rachis,  $\times 4$  (*a-c* MATTHEW 617, *d-e* cult. R. B. G. Kew).

1. *Culcita javanica* (BL.) MAXON, J. Wash. Ac. Sc. 12 (1922) 456; BACKER & POSTH. Varenfl. Java (1939) 22.—*Dicksonia javanica* BL. En. Pl. Jav. (1828) 240; HOOK. Sp. Fil. 1 (1844) 79; C. CHR. Ind. Fil. (1905) 222.—*Dennstaedtia javanica* CHRIST, Bull. Herb. Boiss. II, 4 (1904) 617; v. A. v. R. Handb. (1908) 143.—*Dicksonia copelandii* CHRIST, Philip. J. Sc. 2 (1907) Bot. 183.—*Balantium copelandii* CHRIST in Copel. Philip. J. Sc. 3 (1908) Bot. 301; *ibid.* 4 (1909) 62, t. 19; COPEL. in Elmer, Leaf. Philip. Bot. 2 (1908) 395; v. A. v. R. Handb. Suppl. (1917) 76.—*Balantium javanicum* COPEL. Philip. J. Sc. 4 (1909) Bot. 62; v. A. v. R. Handb. Suppl. (1917) 75.—*Balantium pilosum* COPEL. J. Str. Br. R. As. Soc. n. 63 (1912)

71; Sarawak Mus. J. 2 (1917) 335; v. A. v. R. Handb. Suppl. (1917) 76.—*Dennstaedtia paraphysata* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 16 (1914) 7; Handb. Suppl. (1917) 128.—*Dennstaedtia multifida* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 20 (1915) 10; Handb. Suppl. (1917) 129.—*C. copelandii* MAXON, J. Wash. Ac. Sc. 12 (1922) 457; C. CHR. Ind. Fil. Suppl. 3 (1934) 57; Gard. Bull. S.S. 7 (1934) 224; COPEL. Fern Fl. Philip. 1 (1958) 86.—*C. pilosa* C. CHR. Ind. Fil. Suppl. 3 (1934) 57.—Fig. 34a-c.

*Caudex* ascending or erect (to 60 cm high, *fide* COPELAND), apex covered with rather stiff dark brown hairs to 10 mm long. *Stipes* to 100 cm or more, dark and densely hairy like the rhizome

at the base, pale and more sparsely hairy above the base; main rachis covered beneath with lax pale hairs 2 mm long and scattered dark thicker ones 3–4 mm long, upper surface with dense pale hairs in the groove. *Lamina* c. 150 cm long, basal pinnae to at least 50 cm; largest pinnules about 180 by 100 mm; tertiary leaflets to 50–60 by 30 mm; several free quaternary leaflets on larger pinnules, largest to about 12 by 4 mm, deeply lobed; quinary lobes up to 5 or 6; veins in largest quinary lobes pinnate, in smaller ones forked or simple. *Sori* usually one to each quinary lobe, at the end of the basal acroscopic vein if the vein in the lobe is branched; sori little over  $\frac{1}{2}$  mm  $\sigma$ , when young quite enclosed by the two indusia which appear almost equal, the inner more or less reflexed at maturity and then seen to have a thinner edge. *Hairs* c. 1 mm, pale and spreading, rather numerous on lower surface of pinnule-rachis and axes of tertiary leaflets, more sparse on quaternary leaflets and veins; hairs of the same kind more sparse on upper surface of axes.

Type specimen: BLUME, Java (L.).

Distr. *Malaysia*: Java, Lesser Sunda Is (Lombok, Flores), Sarawak and North Borneo, Philippines (Luzon, Negros).

Ecol. In Java at 1500–2300 m, in wet shady forest (BACKER & POSTHUMUS; but some specimens so named by POSTHUMUS are *Microlepia*); in the Philippines common at 1500–2000 m in Benguet Prov., N. Luzon and found at 1200 m in Negros; in Sarawak and North Borneo found at 1250–1600 m, on a landslide and on a ridge-top. Probably plants establish themselves in open places in forest and on landslides and persist when shadier conditions develop, as in the case of *Cibotium*. In exposed places, plants with small fronds may be fertile; one such was apparently the type of *Balanium pilosum*.

**2. *Culcita villosa*** C. CHR. Brittonia 2 (1937) 283; COPEL. Philip. J. Sc. 78 (1949) 7.

*Caudex* "short, woody" (BRASS). *Stipes* to 80 cm, dark at base and covered with shining brown

hairs 10 mm long with thick bases, pale and glabrescent above base. *Pinnae* to at least 50 cm long; pinnules to 150 by 70 mm; tertiary leaflets to 50 mm long; quaternary leaflets or segments to 12 pairs, largest 13 mm long, mostly about 10 by 3 mm with 5 pairs on quinary lobes; basal acroscopic quinary lobe bearing 3 sori, quite filling the lobe, 2 sori on next lobe, one on each remaining acroscopic and on all basiscopic lobes; inner indusium very delicate, fringed on the edge, pushed back and hidden by ripe sporangia. *Hairs* on lower surface of all axes and veins very copious.

Type specimen: BRASS 4791, Vanapa Valley, 1900 m, Papua (BM).

Distr. *Malaysia*: New Guinea, west to east; N. Celebes (G. Tampusu, coll. HUTTON).

Ecol. Secondary growth (on old garden land) and in grassland, at 1600–2230 m.

**3. *Culcita straminea*** (LABILL.) MAXON, J. Wash. Ac. Sc. 12 (1922) 457; COPEL. Fern Fl. Philip. 1 (1958) 86.—*Dicksonia straminea* LABILL. Sert. Austr. Cal. (1824) 7, t. 10. —*Sitobolium stramineum* BRACK. in Wilkes, U.S. Expl. Exped. 16 (1854) 273.—*Dicksonia torreyana* BRACK. l.c. 278, t. 58, f. 2.—*Dennstaedtia straminea* J. SM. Hist. Fil. (1875) 265.

*Caudex* erect, up to 3 m (BRACKENRIDGE). *Fronds* including stipes to 300 cm long, stipes to 120 cm; lamina similar in size and dissection to that of *C. javanica* but less hairy; inner indusia large, at maturity broader than outer, always evident and not deflexed at maturity.

Type specimen: LABILLARDIÈRE, New Caledonia (P; not seen).

Distr. Polynesia (Samoa, Fiji), Melanesia (New Caledonia, New Hebrides, Solomon Is), and *E. Malaysia*: Louisiades, Admiralty Is, and Philippines (Mindanao).

Ecol. In lowland country, up to 900 m (most specimens below 250 m), growing with *Gleichenia* on deforested slopes, in secondary forest and on river banks.

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All suprageneric and infrageneric epithets have been entered under the name to which they belong preceded by the indication of their rank.

New epithets and new combinations have been printed in **bold type**, synonyms in *italics*.

An *asterisk* behind a page number marks the presence of a figure of the concerned taxon.

Page numbers in **bold type** denote main treatment.

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## LINDSAEA-GROUP (K. U. Kramer, Utrecht)

Small to medium-sized, rarely large, terrestrial or epiphytic ferns. *Rhizome* creeping, terrestrial and radially symmetric or nearly so, solenostelic or more often with a special type of protostele with internal phloem but without internal endodermis and medulla; or epiphytic and with a similar but strongly dorsiventral protostele with the internal phloem close to the dorsal side of the xylem, or in some small species the xylem strand open and U-shaped. *Petioles* with a single U- or V-shaped vascular bundle. *Indument* of the rhizome of scales, these non-peltate, non-clathrate (in *Mal. spp.*), glabrous, entire, or with weakly developed teeth of two protruding cell-ends; terminal cell of scale glandular. Juvenile leaves with similar but narrower, caducous scales. In some species some or even all scales are entirely uniseriate but not true hairs. Laminal parts with scattered microscopical two-celled hairs, hardly ever with macroscopically visible hairs. Axes of leaves adaxially with a single groove bordered by ridges, both mostly continuous with those on axes of different order. *Lamina* once pinnate to decom-pound (rarely simple in a single Old World *sp.*), anadromous. Ultimate divisions various, often dimidiate. Veins free, or reticulate without free included veinlets, not reaching the margin. *Sori* terminal on one to many veins, often on a com-missure  $\pm$  parallel to the margin, submarginal, indusiate; indusium attached at its base, the sides free or adnate, the free edge next to the leaf-margin and often  $\pm$  equaling it. Sporangia  $\pm$  long-stalked, with a triseriate stalk; bow of annulus interrupted; stomium well differentiated or not. Spores trilete or less often mono-lete, without perisporium, smooth or with little sculpture. Paraphyses mostly, perhaps always, present, filiform, 2- to many-celled, often early disappearing. Gametophyte known in very few species, cordate.

*Distribution.* Pantropic, extending considerably beyond the tropics in Japan, Australia, South Africa, and eastern South America; comparatively weakly represented in continental Africa. Six genera: *Odontosoria* (10 American *spp.*, 2 African *spp.*), *Ormoloma* (2 *spp.*, neotropical), *Tapeinidium* (17 *spp.*, SE. Asia to Samoa), *Sphenomeris* (11 *spp.*, pantropic-subtropic), *Xyopteris* (monotypic, Malesian), and *Lindsaea* (c. 150 *spp.*, pantropic-subtropic).

The group is much more diversified in the Old than in the New World, but species here regarded as primitive occur in both hemispheres, and the origin and early history of the group cannot be traced; there are no fossils that can be positively attributed to one of its genera.

*Ecology.* Most Lindsaeoid ferns are forest plants, but some of them occur often or mostly by and in beds of watercourses. A number of species grow on rocks in locally moist situations, *e.g.* by the coast (*Lindsaea orbiculata*, *Sphenomeris biflora*). A few prefer open, exposed situations, on banks, in natural and artificial grassland, and may then become somewhat weedy (*Lindsaea ensifolia*). None of the species goes beyond an altitude of c. 3000 m; in subtropical regions the altitudinal limit is, of course, much lower. Above c. 1500 m some species that are otherwise strictly terrestrial are sometimes found on moss-covered tree trunks *etc.* and are then often described on labels as epiphytes which they are not in the true sense of the word.

*Morphology & anatomy.* For an account of the morphology and anatomy of the group see PÉREZ ARBELÁEZ (Bot. Abh. Goebel 14, 1928), WAGNER (Un. Cal. Publ. Bot. 26, 1, 1952), and KRAMER (Act. Bot. Neerl. 6, 1957, 97–134; *ibid.* 15, 1967, 562–584; Blumea 15, 1968, 557–561). To this may be added the following notes on the *sporangium*. The annulus has a bow of c. 8–23 thickened cells. In *Lindsaea* very many species have 10, 11, or 12 bow cells, 11 being a particularly common number. Some species have, however, consistently larger numbers, especially in the sections *Isoloma*, *Osmolindsaea*, and *Tropidolindsaea*, where numbers between 14 and 20 are common. Here the sporangial head is also somewhat larger. This holds for *Tapeinidium*, *Xyopteris*, and *Sphenomeris*, too, where the annulus has 15–23, usually between 16 and 18 indurated cells.

In most species the stomium is morphologically not or scarcely differentiated from the non-indurated part of the annulus. Two to four well-marked lip cells occur, however, in the sections *Isoloma*, *Tropidolindsaea*, and nearly all species of *sect. Schizoloma*. The character appears to fluctuate, with many transitional cases, in *Tapeinidium* and *Sphenomeris*.

The bow of the annulus reaches up to or slightly beyond the insertion of the stalk in *Tapeinidium* and

most species of *Lindsaea*; in the latter genus the taxonomic value of the character is slight. In *Sphenomeris* it is also variable but apparently well-marked and constant for each species (KRAMER, 1957, *l.c.* 106).

**Cytotaxonomy.** Relatively very few chromosome numbers of *Lindsaeoid* ferns are known at present. Moreover, several of them are only approximately known, and in some cases the identity of the plants is uncertain, as can be concluded from the names under which they have been reported.

In *sect. Schizoloma* there are counts of  $n = 88$  for *Lindsaea ensifolia ssp. ensifolia* (MANTON & SLEDGE) and for *L. 'tenera'* (prob. *L. orbiculata var. commixta*) (MANTON),  $c. 88$  for *L. viridis* (BROWNLIE), 44 or 45 for *L. ensifolia ssp. coriacea* (MANTON ex HOLTUM; see KRAMER, 1968),  $c. 42$  for *L. trichomanoides* (as '*cuneata*') (BROWNLIE),  $c. 40$  for *L. prolongata* (BROWNLIE), and  $c. 47$  for *L. vieillardii* (BROWNLIE) and *L. chienii* (KURITA). It seems likely that most, if not all, of these numbers are 44 or twice as many. This was also found in other sections; in *sect. Odontoloma* there is a count of  $n = c. 44$  for *L. repens var. sessilis* (WALKER, *in litt.*) and 44 or 45 for *L. pulchella var. blanda* (WALKER, *in litt.*), in *sect. Lindsaea*  $n = 88$  in *L. portoricensis* (neotropical) (WALKER) and  $c. 84$  in *L. arcuata* (neotropical) (MICKEL, WAGNER & LIM CHEN). Other numbers may or may not be related, e.g. *L. 'nitida'* (= *integra*?) (MANTON in KRAMER) and *L. 'scandens var. terrestris'* (= *L. doryphora*) (MANTON in KRAMER), both  $c. 47$ . The number  $n = 47$  has, however, been found unequivocally in certain species, e.g. *L. 'macraeana'* (= *L. repens var.*) (WAGNER), *L. 'concinna'* (Australia; *L. brachypoda*?) (MANTON in KRAMER) and *L. parallelogramma* (MANTON in KRAMER). The numbers  $c. 50$  and  $c. 100$  reported for *L. decomposita* (= *L. obtusa*?) (MANTON in HOLTUM), from the same section as *L. parallelogramma*, may have been 47 and 94, respectively. *L. 'pectinata'* (prob. *L. oblancoolata*) was also found to have  $c. 50$  chromosomes (MANTON in HOLTUM), but this species is closely related to *L. repens* ( $c. 44$ , see above). In *L. odorata*, placed in *sect. Osmolindsaea*, divergent in its monolete spores but not otherwise very distinct, a polyploid series was found, ranging from  $n = 150$  (MEHRA & KHANNA) or 150–152 (WALKER, *in litt.*), to  $c. 220$  (WALKER, *in litt.*); the report of 82 (MANTON in KRAMER) from Ceylon may be due to misidentification of the plant. A basic number of 50 or 51 for this species seems possible. *L. linearis*, a member of the distinct *sect. Paralindsaea*, was found to have  $n = 34$  (BROWNLIE).

The picture is equally confusing in the related but much smaller genus *Sphenomeris*. In *S. chinensis*, by far the most widespread species, there are reports of  $n = 94$  (MEHRA & KHANNA; KURITA & NISHIDA),  $c. 100$  (BIR; MANTON & SLEDGE), and 145, 146, 147 (MANTON & SLEDGE). Its close relative *S. biflora* was counted as  $n = 48$  (KURITA & NISHIDA). *S. retusa* had  $n = 88$  and  $c. 88$  (WALKER, *in litt.*); another specimen, apparently of hybrid origin, with abortive spores, had 162–164 chromosomes, with univalents (WALKER, *in litt.*). Two counts of  $n = 38$  and 39, respectively, for the New World *S. clavata* (WALKER; WAGNER) are again divergent. It has been suggested that *Sphenomeris* is not a natural genus (WAGNER, *Am. Fern J.* 53, 1963, 4), but morphological data do not seem to support this.

Two species of *Odontosoria* from Jamaica have been counted as  $c. 96$  (WALKER). No counts for *Tapeini-dium* or *Xyopteris* have been found in the literature.

It seems that the numbers 44 and 47 are widespread in the group, and that some counts of approximately one of these numbers are equal to them or have been derived from them. It is also certain that one or more divergent basic numbers occur besides. Differences in basic number are, however, not necessarily connected with considerable morphological ones. It may be hoped that a clearer picture emerges when more data are available and that then some more light may be shed on the affinities in the group.

Principal sources of data: BIR, *Curr. Sci.* 31 (1926) 248; BROWNLIE, *Trans. R. Soc. New Zeal.* 85 (1958) 213; *ibid.* *Bot.* 1 (1961) 1; *Pac. Sci.* 19 (1965) 4; KURITA & NISHIDA, *J. Jap. Bot.* 38 (1963) 4; MANTON in HOLTUM, *Rev. Fl. Mal.* 2 (1954) 623; MANTON in KRAMER, *Act. Bot. Neerl.* 6 (1957) 108; MANTON & SLEDGE, *Phil. Trans. R. Soc. Lond. B* 238 (1954) 127; MEHRA & KHANNA, *J. Genet.* 56 (1959) 296; MICKEL, WAGNER & LIM CHEN, *Caryologia* 19 (1966) 95; WALKER, *Trans. R. Soc. Edinb.* 66 (1966) 169.

**Taxonomy.** In the older literature the *Lindsaea*-group is usually associated with, or included in, the Davallioid ferns, even as late as 1928 by PÉREZ ARBELAÉZ (*l.c.*), although he noted the great differences in scale and rhizome structure, spore morphology, *etc.*, between the two groups. More recent authors have tended to emphasize the differences between them and have placed the *Lindsaeoids* in a separate family (CHING, *Sunyatsenia* 5, 1940, 216), associated them with the very broadly defined *Pteris*-group (COPELAND, *Gen. Fil.* 1947), or placed them in *Dennstaedtiaceae*. In the present Flora, the question of formal delimitation of families has been left open (HOLTUM, *Fl. Mal.* II, 1, 1959, 1–II); therefore no formal status is here proposed for the *Lindsaea* group of genera. I would, however, express the opinion that, though the group is a very natural one, its separation as a distinct family does not seem warranted, in view of its many similarities to *Dennstaedtia* and allied genera.

As expounded in the revision of the American *Lindsaeoids* (KRAMER, 1957, *l.c.*), and in the chapter on the classification of the Malesian representatives (KRAMER, *Blumea* 15, 1968, 557 *seq.*), the leaf pattern, greatly and excessively used in the past, is by itself insufficient as a basis for generic classification. Such genera as have been based entirely on characters of leaf architecture and venation: *Schizoloma*, *Iso-loma*, *Synaphlebiium*, are here merged with *Lindsaea*. Comments on the circumscription of *Sphenomeris* and *Tapeinidium* can be found in the above-cited papers (KRAMER, 1957, 1968, *l.c.*; *Act. Bot. Neerl.* 15, 1967, 562).

KEY TO THE GENERA

- 1. Sori on 1-8 vein-ends; indusium laterally entirely or largely adnate to the lamina; ultimate divisions never dimidiate; veins free.
- 2. Ultimate free divisions not of a linear- or cuneate-divaricate type, subentire to pinnatifid; sori on the lateral margin of the divisions or in their lobes; pluricellular filiform paraphyses usually (always?) present; spores monolete . . . . . 2. **Tapeinidium**
- 2. Ultimate free or nearly free divisions of a linear- or cuneate-divaricate type, with the sorus (sori) on their apical margin; paraphyses 2- or 3-celled, not usually found; spores monolete or trilete . . . . . 1. **Sphenomeris**
- 1. Sori on many vein-ends, or, if on 8 or fewer, the sides of the indusium free, or the pinnules dimidiate, or the veins anastomosing, or these characters combined.
- 3. Ultimate free divisions lanceolate, equal-sided or the base anteriorly auricled; veins free; spores monolete. . . . . 3. **Xyopteris**
- 3. Ultimate free divisions not lanceolate and equal-sided, or, if so, the spores trilete; veins free or anastomosing . . . . . 4. **Lindsaea**

1. SPHENOMERIS

MAXON, J. Wash. Ac. Sc. 3 (1913) 144, *nom. cons.*; COPELAND, Gen. Fil. (1947) 54; Philip. J. Sc. 78 (1949) 24; HOLTUM, Rev. Fl. Mal. 2 (1954) 340; KRAMER, Act. Bot. Neerl. 6 (1957) 152; COPELAND, Fern Fl. Philip. 1 (1958) 115.—*Davallia* J. E. SMITH, Mém. Ac. Turin 5 (1793) 414; HOOKER, Sp. Fil. 1 (1845) 151; and of many other authors; all in part.—*Stenoloma* FÉE, Gen. Fil. (1852) 330, *p.p. min.*; CHING, Fl. Reip. Pop. Sin. 2 (1959) 275, in part; and of other authors.—*Odontosoria* FÉE, Gen. Fil. (1852) 325; J. SMITH, Hist. Fil. (1875) 263; DIELS in E. & P. Nat. Pfl. Fam. I, 4 (1902) 215; v.A.v.R. Handb. (1908) 258; Suppl. (1917) 202; and of many other authors; all in part.

Terrestrial ferns with a short- to moderately long-creeping *rhizome*, if stout with a solenostele with a sclerotic medullary strand, if more slender mostly with a lindsaeoid protostele. *Rhizome scales* elongate-triangular to acicular, in the smaller species some scales wholly uniseriate and therefore the scales grading into hairs. *Petioles* abaxially terete, adaxially upward sulcate. *Lamina* much dissected, decompose, strongly anadromic, without a conform terminal pinna, the ultimate divisions confluent near the pinna-apices, not free and conform (except in the New Caledonian *S. alutacea*). Veins free, simple or forked in the ultimate divisions. *Sori* uni- to paucinerval, on the apical margin of the segments; indusium attached at the base and the sides. Paraphyses 2- or 3-celled, observed in one species (*S. chinensis*), presumably present in all and fugacious. Spores monolete or trilete. Gametophyte undescribed.

Type species: *Sphenomeris clavata* (L.) MAXON (tropical America).

Distr. In the tropics and in the northern subtropical regions of both hemispheres 11 spp., 6 of them with very small areas.

Note. *Sphenomeris* MAXON was conserved against *Stenoloma* FÉE, a name of somewhat controversial application. In the Code of Nomenclature *Stenoloma dumosum* FÉE was at first designated as type species, but afterwards, on MORTON's suggestion (Taxon 8, 1959, 29), this was changed to *Stenoloma clavatum* (L.) FÉE, as this was said to agree much better with the original description of the genus. However, FÉE explicitly mentioned as an essential character of *Stenoloma*, setting it apart from *Odontosoria*, the only basally attached but laterally free indusium. This is not found in any true species of *Sphenomeris*, and certainly not in *Sphenomeris clavata*. The issue should be reconsidered.

KEY TO THE SPECIES

- 1. Rhizome 5-20 mm ø, solenostelic, with an internal sclerotic strand; rhizome scales to 7 mm long, the larger ones to c. 20-seriate at the base; spores trilete; sori of larger segments on (2-)5-8 vein-ends, occupying their whole apical margin (fig. 5) . . . . . 1. **S. retusa**
- 1. Rhizome 2-4 mm ø, with a lindsaeoid protostele; scales to 4 mm long, to 4-seriate at the base (wider in *S. biflora*); spores monolete; sori of larger segments on 1-2(-4) vein-ends, not occupying their whole apical margin.

2. Scales up to 3-seriate at the base; sori strictly uninerval; ultimate divisions  $\frac{1}{2}$ – $\frac{3}{4}$  mm wide, or the fertile gradually widened to the sorus and there 1 mm wide; texture coriaceous . . . 4. *S. veitchii*
2. Scales to 5–6-seriate at the gradually widened base; sori uni- or binerval; larger free ultimate divisions c. 2 mm wide; lamina subcoriaceous or coriaceous, usually bipinnate + pinnatifid or tripinnate + crenate . . . 2. *S. biflora*
2. Scales 1–3-seriate (or to 4-seriate at the suddenly broadened base); sori 1–3(–4)-nerval; larger free ultimate divisions 1 mm or more wide, or, if narrower, spatulately widened at the sorus; lamina herbaceous to subcoriaceous, in full-grown plants bipinnate + bipinnatifid, tripinnate + pinnatifid, or more dissected . . . 3. *S. chinensis*

1. *Sphenomeris retusa* (CAV.) MAXON, J. Wash. Ac. Sc. 3 (1913) 144; COPELAND, Philip. J. Sc. 78 (1949) 24; Fern Fl. Philip. 1 (1958) 116.—*Davallia retusa* CAV. Descr. (1802) 278.—*Stenoloma retusum* (CAV.) FÉE, Gen. Fil. (1852) 330.—*Lindsaea retusa* (CAV.) METT. Fil. Lips. (1856) 105.—*Odontosoria retusa* (CAV.) J. SMITH, Bot. Voy. Herald (1857) 430.—*Schizoloma retusum* (CAV.) KUHN, Chaetopt. (1882) 346. — Type: NÉE s.n., Mt Isarrog, Luzon (MA, n.v.; phot. U).  
*Lindsaea cuneifolia* PRESL, Rel. Haenk. 1 (1825) 60.—? *Saccoloma cuneifolium* PRESL, Tent. Pterid. (1836) 126. — *Acrophorus cuneifolius* (PRESL) MOORE, Ind. Fil. (1857) 41. — Type: HAENKE s.n., Luzon (n.v.).

? *Adiantum falcatum* BLANCO, Fl. Filip. (1837) 833. — Type: BLANCO s.n., 'Mandalogon' (n.v.; perhaps this species acc. to C. CHR. Ind. Fil. Suppl. 1, 1913, corr. 89).

*Davallia decipiens* CESATI, Rendic. R. Accad. Sci. Fis. Mat. Napoli 16 (1877) 29.—*Odontosoria decipiens* (CESATI) CHRIST, Nova Guinea 8 (1909) 158.—Type: BECCARI s.n., Mt Arfak at Putat, W. New Guinea (FI, 2 sh.).

*Odontosoria lindsayae* v.A.V.R. Bull. Dép. Agr. Ind. Néerl. 21 (1908) 4.—Type: not cited; 3 sh. so annotated in BO; on the ground of the date chosen as lectotype: VERSTEEG 1467, s.w. W. New Guinea, prob. back of Sabang (BO; dupl. in B, K, L, U). — Fig. 5.

*Rhizome* probably short-creeping (only short pieces seen), enveloped in a dense mass of roots, stout, in full-grown plants  $\frac{1}{2}$ –2 cm  $\sigma$ , with an internal sclerotic strand; scales dark reddish brown, elongate-triangular, to 7 mm long, to c. 20-seriate at base, a short apical portion uniseriate. *Petioles* stramineous or darker with age, the base often slightly verrucose from scale-bases, 2–15 mm  $\sigma$  at base, 20–70 cm long (on labels said to attain 1.6 m), c.  $\frac{2}{3}$ –1 times as long as the lamina; all axes abaxially rounded, marginate near the ultimate divisions. *Lamina* oblong-triangular, to 3 m long, mostly brown or olivaceous when dry, chartaceous to coriaceous, subtripinnate to tripinnate + pinnatifid, or less often quadripinnate. *Major pinnae* 5–12 to a side, alternate or the lower ones subopposite, obliquely ascending, the lower ones with a stalk of 1–2 cm, the upper ones gradually sessile, elongate-triangular, to 30 by 12 cm, caudate-acuminate, equal-sided but the larger pinnae basiscopically in their basal part often slightly narrower. Lower pinnae their width apart or more, the upper ones usually somewhat overlapping. *Larger secondary pinnae* narrowly

triangular, shortly petiolulate, acuminate, c. 5–10 cm long,  $2\frac{1}{2}$ –6 cm wide, pinnate + pinnatifid or less often bipinnate, basiscopically narrower, with often 3 or 4 free pinnules to a side, the larger ones pinnatifid or less often pinnate, the upper ones cuneate, confluent; upper primary and distal secondary pinnae rhombic, submidiate, basiscopically more narrowly cuneate. Apices of primary and secondary, sometimes also of tertiary pinnae narrow, serrate,  $\pm$  caudiform. *Ultimate pinnules*, except if transitional between pinnate and non-pinnate ones, subrhombic and with a few very shallow incisions, or cuneate and entire, often 7–15 mm long and 5–10 mm wide,  $1\frac{1}{2}$ –2 times as long as wide (upper, smaller ones relatively narrower), evenly cuneate from the base, widest at the truncate or just below the triangular apex, with straight or slightly convex, sometimes subrevolute lateral edges. The quadripinnate form with narrower pinnules, c. 5–6 by 2 mm,  $2\frac{1}{2}$ –3 times as long as wide. Sterile pinnules (hardly found in full-grown plants) crenate-cleft. Veins adaxially impressed, abaxially prominulous, usually twice forked; close, c.  $\frac{1}{2}$  mm apart. *Sori* continuous across the whole apical margin of cuneate, interrupted in subrhombic pinnules and then continuous across the separate straight portions of their apical margin, on 5–8 vein-ends and to 5 mm long, in smaller segments or lobes shorter, in the quadripinnate form often bi- to quadrinerval. Indusium pale to brown, entire, the slightly narrowed sides adnate, rather thin, 0.4–0.6 mm wide, almost reaching the margin, bulging but scarcely reflexed at maturity. Spores medium brown, trilete, almost smooth, c. 38–40  $\mu$ .

*Distr. Malesia:* Celebes, Philippines (almost throughout), Moluccas (Morotai, Halmahera, Tidore, Ambon, Ceram), New Guinea, Admiralty Is., Bismarck Arch.; Solomon Is., ?New Hebrides.

*Ecol.* On banks, in open places, often among rocks by rivers, less often in forests, from sea level to c. 2000 m.

*Note.* A quadripinnate form with narrower pinnules and shorter sori, as described above, has been collected several times in New Guinea and also in Manus. It is not sharply distinct from the broader, less dissected form. Its status is uncertain; one specimen had an irregular meiosis (WALKER, pers. comm.) and proved to have abortive spores; it is almost certainly a hybrid (with *S. chinensis*?), but this is scarcely the case with all.

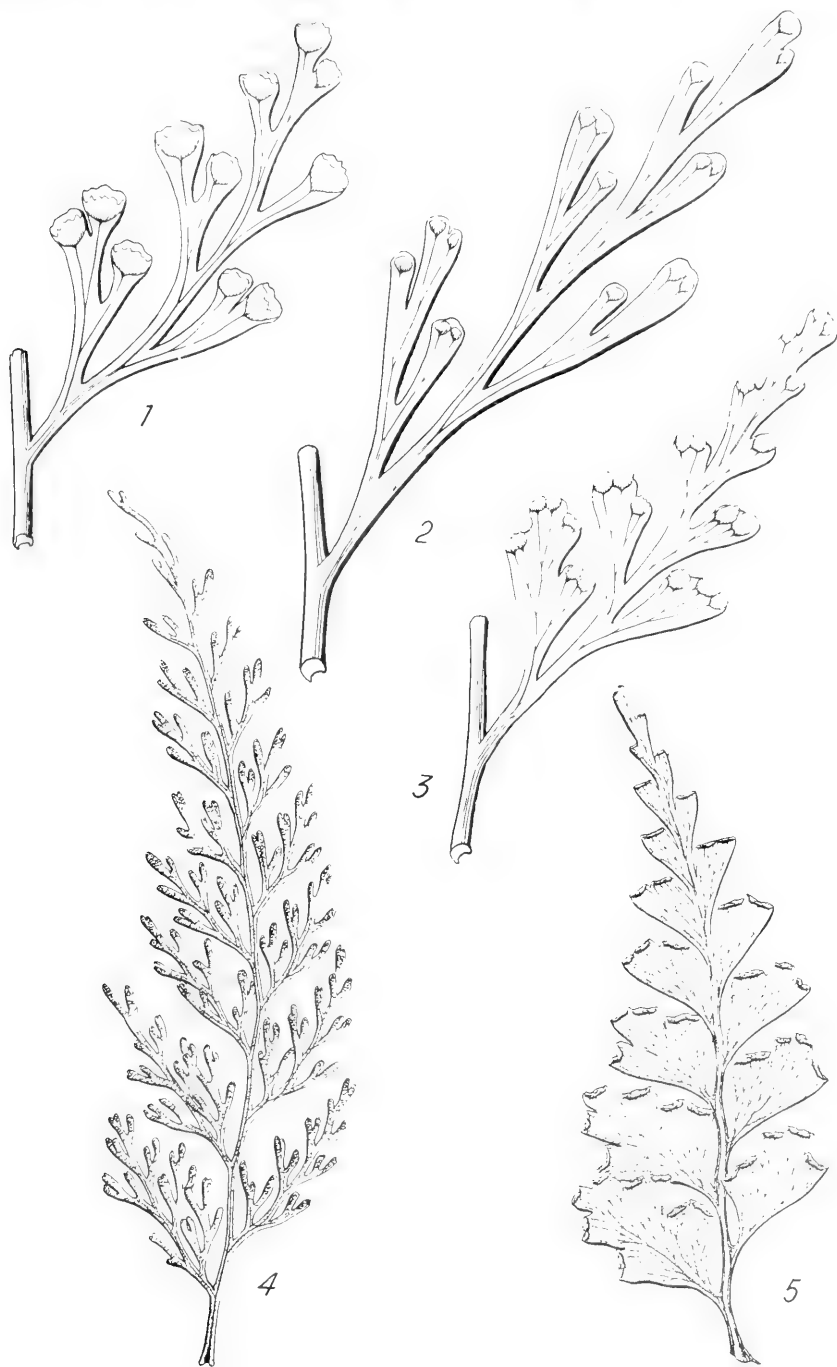


Fig. 1-3. *Sphenomeris chinensis* (L.) MAXON.—Fig. 1. var. *divaricata* (CHRIST) KRAMER. Pinnule,  $\times 4$  (RANT 21).—Fig. 2. var. *rheophila* KRAMER. Pinnule,  $\times 4$  (SURBECK 315).—Fig. 3. var. *chinensis*. Pinnule,  $\times 4$  (BARTLETT & DE LA RUE 77).—Fig. 4. *S. veitchii* (BAKER) C. CHR. Pinna,  $\times 1\frac{1}{4}$  (CLEMENS 50992).—Fig. 5. *S. retusa* (CAV.) MAXON. Pinnule,  $\times 1\frac{1}{4}$  (KOORDERS 17033).

2. *Sphenomeris biflora* (KAULFUSS) TAGAWA, J. Jap. Bot. 33 (1958) 203; KRAMER, Blumea 15 (1968) 573.—*Davallia biflora* KAULFUSS, Enum. (1824) 221.—*Microlepia biflora* (KAULFUSS) METT. Fil. Lips. (1856) 104. — *Odontosoria biflora* (KAULFUSS) C. CHR. Ind. Fil. (1906) 464. — *Stenoloma biflorum* (KAULFUSS) CHING, Sinensia 3 (1933) 338; TAGAWA, J. Jap. Bot. 22 (1948) 160.—Type: CHAMISO *s.n.*, Manila, Luzon (B).

*Davallia tenuifolia* SWARTZ var. *lata* HOOKER ex MOORE, Ind. Fil. 2 (1861) 301, based on  $\beta$  (unnamed) of HOOKER, Sp. Fil. 1 (1845) 186.—Lectotype: Exp. Acad. Petersb. 44, Bonin (K).

*Odontosoria tsoongii* CHING, Bull. Fan Mem. Inst. Biol. 1 (1930) 149. — Lectotype: TSOONG 1423, Hailin Is., Kwangtung, China (*n.v.*).

*Stenoloma littorale* TAGAWA, Act. Phytotax. Geobot. 6 (1937) 225. — *Stenoloma chusanum* (L.) CHING var. *littorale* (TAGAWA) ITO, Bot. Mag. Tokyo 52 (1938) 6.—*Sphenomeris chusana* (L.) COPELAND var. *littoralis* (TAGAWA) H. ITO ex MIZUSHIMA, Misc. Rep. Inst. Natur. Res. 38 (1955) 115 (quoted by TAGAWA, Col. Ill. Jap. Pterid. 1959, 256, *n.v.*) — Type: TASIRO *s.n.*, Oshima I., Shikoku (KYO, *n.v.*).

*Sphenomeris chinensis* or *chusana*, etc., of various authors, in part, e.g. COPELAND, Fern Fl. Philip. 1 (1958) 115.

*Rhizome* short-creeping, 2–3 mm  $\phi$ ; scales golden to medium brown, occasionally castaneous, to 3½ mm long, in the larger ones the apical half or less uniseriate, acicular, the lower part gradually broadened to the 5–6-seriate (exceptionally even broader) base. Leaves clustered; *petioles* stramineous to pale brown, dull, abaxially terete, or flattened and obtusely bi-angular, adaxially sulcate, c. 10–25 cm long, almost equalling to about half as long as the lamina. *Lamina* oblong or less often triangular or sub-pentagonal, c. 15–35 cm long, subcoriaceous or more often coriaceous, olivaceous when dry, the upper side often blackish, bipinnate + pinnatifid or tripinnate + pinnatifid, with 7–12 major pinnae to a side; primary rachis abaxially subterete or usually upward  $\pm$  flattened and gradually marginate. *Primary pinnae* elongate-triangular or narrowly triangular, obliquely ascending, or in small leaves spreading, with a petiolule of a few mm, subacute to acuminate, the lower ones about their width apart, the upper ones closer, the larger ones c. 5 by 1½ to 13 by 5 cm, with 3–6 pinnate secondary pinnae, and some subentire to pinnatifid upper ones, to a side, the apex pinnatifid-serrate; secondary rachises abaxially rounded, at least upward, marginate. Upper pinnae gradually reduced, sometimes the basal pair slightly shorter than the next. Lower pinnae in their basal part usually more compound than the rest of the lamina, the basal basiscopic secondary pinnae sometimes larger than all the others. Axes of higher order often  $\pm$  flexuous. Smaller *pinnules* rhombic, pinnatifid + pinnatisect or forked, the smallest entire, obtriangular-cuneate. Largest free or nearly free non-dissected pinnules

(segments) often 5 by 2 mm, asymmetric, decurrent, with straight or more often upward rounded sides, usually widest just below the apex, the apical margin subtruncate, erose to shallowly crenate, or subentire, mostly with two small latero-apical projections, the thickened lateral margins often  $\pm$  revolute. Veins immersed or usually slightly prominulous on both sides, forked, the ultimate segments, except the smallest, with two to several veins. *Sori* one or not rarely two per segment, or, if more, separated by incisions, uni- or occasionally binerval; indusium elliptic, very convex at the base, adnate at the  $\pm$  convex sides, rigid, the free margin rounded, subtruncate,  $\pm$  equaling the margin, or not rarely with lobes exceeding the margin, 1 mm wide, ½–1¼ mm long (at right angles to vein). Spores monolet, ellipsoid, medium brown, smooth, c. 32–35 by 40–45  $\mu$ .

Distr. S. Japan, Bonin Is., Guam, Hong Kong and other islands on the Chinese S. coast; in *Malesia*: only in Luzon and the Batanes Is.

Ecol. Very few data from *Malesia*; elsewhere in  $\pm$  exposed places, often by the sea, never in forests; at lower and middle elevations, to c. 1300 m.

Note. The more dissected forms of *S. biflora* can be safely distinguished from the larger, broader forms of *S. chinensis* var. *chinensis* only by the rhizome scales.

3. *Sphenomeris chinensis* (L.) MAXON, J. Wash. Ac. Sc. 3 (1913) 144; Contr. U.S. Nat. Herb. 17 (1913) 159 (in both places the basionym incorrectly cited as *Adiantum chinense* L.); C. CHR. Ind. Fil. Suppl. 2 (1917) 31; KRAMER, Act. Bot. Neerl. 15 (1967) 565; Blumea 15 (1968) 572; FOSBERG, Taxon 18 (1969) 596.—*Trichomanes chinense* L. Sp. Pl. 2 (1753) 1099.—*Adiantum chinense* (L.) BURMAN, Fl. Ind. (1768) 236 (prob.).—*Davallia chinensis* (L.) J. E. SMITH, Mém. Ac. Turin 5 (1793) 414. — *Microlepia chinensis* (L.) METT. Fil. Lips. (1856) 104. — *Odontosoria chinensis* (L.) J. SMITH, Bot. Voy. Herald (1857) 430.—*Davallia tenuifolia* (LAMK) SWARTZ var. *chinensis* (L.) MOORE, Ind. Fil. 2 (1861) 302. — *Lindsaea chinensis* (L.) METT. ex KUHN, Fil. Afr. (1868) 67, non CHING (1929).—*Stenoloma chinense* (L.) BEDD. Handb. Ferns Br. Ind. (1883) 70. — Type: OSBECK *s.n.*, China (S-PA).

*Adiantum chusanum* L. Sp. Pl. 2 (1753) 1095.—*Davallia chusana* (L.) WILLD. Sp. Pl. 5 (1810) 475. — *Sphenomeris chusana* (L.) COPELAND, Bull. Bish. Mus. 59 (1929) 69; Philip. J. Sc. 78 (1949) 24; HOLTUM, Rev. Fl. Mal. 2 (1954) 341; COPELAND, Fern Fl. Philip. 1 (1958) 115. — *Odontosoria chusana* (L.) MASAM. Mem. Fac. Sci. Agr. Taihoku Imp. Univ. 11 (1934) 67.—Type: coll.?, China (*n.v.*).

*Adiantum tenuifolium* LAMK, Encycl. 1 (1783) 44. — *Davallia tenuifolia* (LAMK) SWARTZ in Schrader, J. Bot. 1800<sup>2</sup> (1801) 88. — *Stenoloma tenuifolium* (LAMK) FÉE, Gen. Fil. (1852) 330. — *Microlepia tenuifolia* (LAMK) METT. Fil. Lips.



(1856) 104, pl. 27, f. 1-4, *non* PRESL (1851).—*Odontosoria tenuifolia* (LAMK) J. SMITH, Cat. Cult. Ferns (1857) 67. — *Odontosoria chinensis* (L.) J. SMITH var. *tenuifolia* (LA)MK MATSUM. Ind. Pl. Jap. (1904) 330.—*Sphenomeris chinensis* (L.) MAXON var. *tenuifolia* (LAMK) C. CHR. Dansk Bot. Ark. 7 (1932) 78. — *Odontosoria chusana* (L.) MASAM. var. *tenuifolia* (LAMK) (err. 'MAK.') MASAM. Mem. Fac. Sci. Agr. Taihoku Imp. Univ. 11 (1934) 67.—*Sphenomeris chusana* (L.) COPELAND var. *tenuifolia* (LAMK) HOLTUM (incorr. ascr. to C. CHR.), Rev. Fl. Mal. 2 (1954) 341, as to type only. — Type: SONNERAT s.n., 'Inde' (P).

*Davallia didyma* HEDWIG, Fil. Gen. & Sp. (1803) pl. 22, *ex icon*.—Type: not cited.

*Davallia microcarpa* J. E. SMITH in Rees, Cyclop. 11 (1808) *sine pag.*—Type: CHR. SMITH s.n., Amboina (LINN).

*Hymenophyllum ramosissimum* HAM. ex D. DON, Prod. Fl. Nepal. (1825) 12. — Type: HAMILTON s.n., Nilkantha, Nepal (*n.v.*; identity teste C. CHR. Ind. Fil.).

*Trichomanes malayanum* ROXB. ex GRIFF. Calc. J. Nat. Hist. 4 (1844) 519.—Type: coll.? 'native of the Malay Islands' (*n.v.*; identity uncertain).—Fig. 1-3.

*Rhizome* short-creeping, 2-4 mm  $\sigma$ ; scales reddish brown to castaneous, acicular, entirely uniseriate, or the base often biseriate, less often the extreme base tri- or quadriseriate, to 4 mm long. Leaves clustered; *petioles* stramineous with darker base, or darker with age, abaxially terete, adaxially upward gradually sulcate, the groove broad and flat; *petioles* of full-grown plants  $1\frac{1}{2}$ -3 mm  $\sigma$  in the middle, c. 12-60 cm long,  $\frac{2}{3}$ -1 times as long as the lamina, shorter and more slender in juvenile but fertile plants. *Lamina* oblong, elongate-ovate, or narrowly triangular, 15-85 cm long (rarely smaller in fertile plants), usually olivaceous, medium or dark brown to blackish when dry, herbaceous to chartaceous or occasionally subcoriaceous, if fertile at the base at least bipinnate + pinnatifid, usually bipinnate + bipinnatifid or tripinnate + pinnatifid, or in large specimens up to quadripinnate + pinnatifid. Primary rachis and axes of higher order stramineous, abaxially terete, upward gradually marginate. Larger leaves with c. 6-10 major *primary pinnae* to a side; *pinnae* rather strongly spreading to strongly ascending, elongate-triangular or -rhombic, with a stalk of a few mm to 3 cm, the base usually inequilateral, the anterior side broader as the pinna is strongly anadromic and the anterior side has longer and/or less ascending pinnules, the apex acuminate; larger *pinnae* (5-)-10-20 cm long, ( $1\frac{1}{2}$ -)3-10 cm wide, 2-4 $\frac{1}{2}$  times as long as wide, the lower ones usually subopposite and several cm apart, the upper ones gradually alternate, smaller, and closer. *Secondary pinnae* triangular or rhombic, acute or acuminate, ascending, shortly petiolulate, alternate, often c. 6-8 major ones to a side, often twice as long as wide, size and dissection depending upon size and dissection of the lamina and their place

in it. Largest *ultimate free divisions* rhombic, asymmetric, pinnatisect on both sides, smaller ones cuneate, unequally and shallowly bifid, or, if deeply bifid, usually once again bifid, linear-spathulate to cuneate (depending on the variety; see below). Veins immersed, in dry material usually little or not evident. *Ultimate lobes* uni- or binerval, or in broader forms occasionally to quadrinerval,  $\frac{1}{2}$ -2 mm wide at the apex, the larger undivided ones 2-3 mm long, the ones below them incised, the ones above them reduced, denticuliform, confluent into a pinnatifid, often caudate-acuminate pinna-(pinnula)-apex. Sterile lobes apically subacute, or, if broader, often denticulate. Fertile lobes with straight or slightly convex apical margin, broader ones not rarely erose-denticulate. *Sori* on 1 or 2, less often on 3, exceptionally on 4 vein-ends, not quite reaching the apico-lateral extremities of the lobes; indusium brownish and chartaceous when dry, with  $\pm$  straight to convex base, adnate, convex sides, and straight, slightly convex, or sometimes erose-denticulate free margin,  $\pm$  equaling or, if denticulate, sometimes slightly exceeding the margin, never reflexed at maturity. Spores monolet, ellipsoid, smooth, medium brown.

*Distr.* Throughout the tropical and subtropical parts of the Old World, but wanting in continental Africa.

1. var. *rheophila* KRAMER, Blumea 15 (1968) 573.—Type: BARTLETT 6718a, Sumatra, Asahan, waterfall of Asahan R. (L; dupl. in GH, MICH, S-PA, US).—Fig. 2.

Lamina 15-20 cm long, tripinnate + pinnatifid or less often bipinnate + bipinnatifid at the base; segments rigid, often with  $\pm$  revolute margin, narrowly cuneate, gradually broadened to base, most of them monosorous and 4-5 times as long as wide, often 4-5 by 1 mm. Outer edge of segments entire or sinuate. *Sori* on one, less often on two (mostly connivent) vein-ends; indusium often  $\frac{1}{2}$  by  $\frac{1}{2}$  mm, with convex base. Spores as in var. *chinensis*, c. 44-48  $\mu$  long, but more elongate, bean-shaped,  $\pm$  twice as long as broad.

*Distr.* *Malesia*: Pahang and Central Sumatra (9 coll.).

*Ecol.* By torrents and waterfalls, on riverbanks, 100-500 m.

2. var. *divaricata* (CHRIST) KRAMER, Blumea 15 (1968) 572.—*Odontosoria chinensis* (L.) J. SMITH var. *divaricata* CHRIST, Journ. de Bot. sér. 2, II (1909) 23.—*Sphenomeris chusana* (L.) COPELAND var. *divaricata* (CHRIST) TARDIEU-BLOT, Fl. Madag. Com. 5e fam. I (1958) 29.—Type: CHEVALIER 14309, São Tomé (P).

*Sphenomeris chusana* (L.) COPELAND var. *tenuifolia* of HOLTUM, Rev. Fl. Mal. 2 (1954) 341, and of other authors; not *Adiantum tenuifolium* LAMK.—Fig. 1.

Lamina usually over 20 cm long, at the base often tripinnate + bipinnatifid; segments cuneate, suddenly spathulate-broadened at the sorus, slightly narrowed at the rounded apex, the apical margin not rarely erose, the sides often corn-

iculate; at the base often  $\frac{1}{2}$  mm wide, slightly broadened to the apex,  $1-1\frac{1}{4}$  mm wide at the sorus, of varying length; sori not rarely two together in a segment, mostly uninerval, if binerval mostly on two connivent vein-ends; indusium even in binerval sori with distinctly convex base. Spores mostly  $55-60\ \mu$  long.

Distr. São Tomé; sporadically from Sikkim and S. China to *Malesia*: throughout *Malesia*, common in Sumatra, Java, and New Guinea, rare in Borneo (Sarawak only) and local in the Philippines (Luzon, Mindanao).

Ecol. As the next variety, but mostly above 700 m.

Note. See the note at the end of the species.

**3. var. chinensis.**—In so far as known most or all of the synonyms enumerated under the species apply to this variety.—Fig. 3.

Lamina of variable length, at the base often tripinnate + pinnatifid; segments cuneate, gradually broadened from the base, rarely with one sorus only, except the upper, reduced ones, usually with several sori and shallow incisions between them (not entire and with one sorus across the apical margin, as in *S. retusa*), often  $\pm$  twice as long as wide, the apical margin not or scarcely erose; sori not rarely uninerval, most often bi- or tri-, rarely to quadrinerval, to 2 mm long, most often  $\frac{3}{4}-1\frac{1}{2}$  mm long. Spores mostly  $42-48\ \mu$  long.

Distr. As the species.

Ecol. Terrestrial and on rocks, in thickets and open forests, in exposed or lightly shaded places, often by hollow roads, on slopes, escarpments, by streams, etc., 100–2400 m, apparently most common from c. 800–1500 m, often said to be locally numerous.

Notes. The three varieties of *S. chinensis*, notably the last two, are not quite sharply distinct; this is one reason for treating them as varieties. Intermediates between *var. chinensis* and *var. divaricata* occur not rarely, but are much less numerous than typical specimens. The two varieties overlap throughout *Malesia*, only in New Guinea the former is quite rare and the latter relatively frequent. On the continent *var. divaricata* becomes increasingly rare to the North and West; it is absent from Japan and nearly so from China. In the Pacific it has not been found so far. However, on many islands a form occurs with narrower, mostly monosoral segments and prevalently uninerval sori. It lacks the spatulate segments of *var. divaricata* and is therefore regarded as an aberrant form of *var. chinensis*. Similar specimens occur here and there in *Malesia*, too, notably in Celebes. Their taxonomic status

cannot be elucidated with the help of dried material only. A form with exceptionally broad segments occurs in Sumatra. It has been confused with *S. retusa* and *S. biflora*, but must be assigned to *S. chinensis* because of its monoete spores and its narrow rhizome scales, and some other characters, too.

**4. *Sphenomeris veitchii* (BAKER) C. CHR.** Gard. Bull. S. S. 7 (1934) 234.—*Davallia veitchii* BAKER, J. Bot. 17 (1879) 39.—*Stenoloma veitchii* (BAKER) C. CHR. Ind. Fil. Suppl. 3 (1934) 174.—Type: BURBIDGE 49 or *s.n.*, Mt Kinabalu, Sabah (K, 2 sh.; dupl. in BM).—Fig. 4.

*Rhizome* rather long-creeping, c. 4 mm  $\phi$ ; scales dark castaneous, acicular, the upper half uniseriate, the base bi- to triseriate, to  $2\frac{1}{2}$  mm long. Leaves  $\frac{1}{2}-1$  cm apart; *petioles* slender,  $1\frac{1}{2}-2$  mm  $\phi$ , fuscous or upward stramineous, abaxially terete, adaxially broadly and shallowly grooved, 30–40 cm long. *Lamina* narrowly oblong, c. 30 by 5 to 70 by 15 cm, bipinnate + bipinnatifid or tripinnate + bipinnatifid, with c. 10–20 primary pinnae to a side; primary rachis like the petiole, upward paler and sometimes very obtusely bi-angular. *Basal pinnae* remote, to 12 cm apart, the upper ones gradually closer, subcontiguous, all ascending, elongate-triangular, acuminate, with a stalk of up to 1 cm, pronouncedly anadromic, the larger ones c. 10–12 by 4–5 cm, the upper ones gradually smaller; major *secondary pinnae* c. 6–8 to a side in larger pinnae, rhombic, acute. Axes of secondary and higher order stramineous, adaxially narrowly and deeply sulcate, abaxially rounded or narrowed-rounded, upward gradually somewhat flexuous and marginate, therefore in the lamina the pinnate grading into the pinnatifid condition. *Ultimate segments* rigid, coriaceous, olivaceous when dry, basally often with adaxially raised, thick edges, linear, often 4–5 by 0.5–0.7 mm, the fertile ones gradually to 1 mm wide at the sorus, subobtusely to erose-truncate, the sterile ones acute, the larger ones forked. Veins strictly single and undivided in the lobes, immersed, scarcely visible. *Sori* uninerval; indusium rigid, yellowish, subelliptic, with adnate sides, not reaching the lateral margins of its segment, c.  $\frac{1}{2}-\frac{3}{4}$  mm wide,  $\frac{1}{2}$  mm long (at right angles to its vein),  $\pm$  equaling the often laterally shortly bicorniculate outer margin of the segment, subentire to shallowly erose. Spores monoete, subellipsoid, light brown, smooth, c. 45 by 38  $\mu$ .

Distr. *Malesia*: confined to Mt Kinabalu, Sabah, Borneo (3 coll.).

Ecol. In mountain forests, 2000–2500 m.

## 2. TAPEINIDIUM

(PRESL) C. CHR. Ind. Fil. (1906) 631; COPELAND, Gen. Fil. (1947) 53; HOLTUM, Rev. Fl. Mal. 2 (1954) 338; KRAMER, Blumea 15 (1968) 545.—*Microlepia* sect. *Tapeinidium* PRESL, Epimel. Bot. (1851) 968.—*Protolindsaya* COPELAND, Philip. J. Sc. 5 (1910) Bot. 283.—*Wibelia* auct. non BERNHARDI; FÉE, Gen. Fil. (1852)

331; DIELS, in E. & P. Nat. Pfl. Fam. I, 4 (1902) 216.—*Davallia* or *Microlepia auctt. plur.*, p.p.

Small to medium-sized terrestrial ferns with very short to moderately long-creeping *rhizome* with at least in the larger species a true solenostele with external and internal endodermis and a medullary strand of sclerenchyma. Scales long and narrow, glabrous, non-clathrate. *Lamina* up to the last divisions pinnately compound, at least once pinnate; ultimate divisions not dichotomously divaricate. Veins free. *Sori* terminal on the veins, uni- or less often binerval (rarely trinerval), mostly close to the margin. Indusium rigid, attached at the base and at least the greater part of the sides. Pluricellular uniseriate filiform paraphyses present (probably in all *spp.*). Spores monolete. Gametophyte unknown.

Type species: *Tapeinidium pinnatum* (CAV.) C. CHR.

Distr. 17 *spp.*, from S. India, the Malay Peninsula, and the Ryu Kyu Is. to Melanesia and Samoa; absent from Australia, probably also from New Caledonia.

Ecol. In forests, mostly at lower and middle altitudes, to c. 2500 m.

#### KEY TO THE SPECIES

1. Lamina simply pinnate and with a conform terminal pinna (fig. 14).
  2. Sori submarginal, most often binerval; petiole and rachis abaxially sharply bi-angular; scales to 5 mm long . . . . . 15. *T. longipinnulum*
  2. Sori intramarginal, almost always uninerval; rachis abaxially sharply bi-angular or sulcate, basally dark and pale-margined; scales to 2½ mm long . . . . . 14. *T. acuminatum*
1. Lamina more strongly dissected, or, if simply pinnate, the upper pinnae reduced and confluent into a pinnatifid leaf-apex, or at least the terminal division strongly lobed at its base.
  3. Lamina simply pinnate, or, if more dissected, the primary rachis abaxially sharply carinate; at least a considerable upper portion of the petiole abaxially bi-angular.
    4. Petiole, at least in the upper part, and rachis dark, pale-angled; lamina pinnate + pinnatifid or bipinnate.
      5. Larger pinnae of full-grown plants 20–25 mm wide at the widest point; texture subcoriaceous; margin often reflexed in dry leaves; lobes of larger pinnae sinuate, the sori not on lobes . . . . . 8. *T. gracile*
      5. Larger pinnae of full-grown plants 10–12 mm wide at the widest point; texture herbaceous; margin not reflexed; lobes of larger pinnatifid or basally subpinnate pinnae lobed, each sorus on a lobe; smaller forms of. . . . . 1. *T. denhamii*
    4. Petiole pale, or, if occasionally darker, the rachis not also dark and pale-angled; or lamina simply pinnate.
      6. Lamina to 12 cm long; petiole slender, less than 1 mm ø . . . . . 10. *T. oligophlebium*
      6. Lamina larger; petiole stouter.
        7. Petiole abaxially obtusely bi-angular, dark and dull, ± pale-angled; rachis abaxially mostly narrowed-rounded; sori submarginal, on saw-teeth; lamina simply pinnate . . . . . 13. *T. prionoides*
        7. Petiole abaxially sharply bi-angular at least near the apex, nearly always pale; rachis abaxially carinate or bi-angular; sori intramarginal; lamina variously dissected.
          8. Lamina pinnate + pinnatifid or more incised\* . . . . . 11. *T. luzonicum*
          8. Lamina simply pinnate or in large leaves the basal pinnae with very few basal lobes\* . . . . . 12. *T. pinnatum*
  3. Lamina at least pinnate + pinnatifid; primary rachis abaxially terete or bi-angular, or, if obtusely carinate, the petiole abaxially not (or only at the apex) sharply bi-angular.
    9. Primary rachis atropurpureous; secondary rachises (except sometimes the basal ones) abruptly pale; pinnae pinnatifid, with crenate segments, only the basal pinnae occasionally with some pinnatifid basiscopic pinnules; most sori with their greatest extension at right angles to their vein. . . . . 9. *T. calomelanos*
    9. Primary rachis at least at the base dark; secondary rachises pale; pinnae pinnate + pinnatifid or subbipinnate; sori with their greatest extension in the prolongation of the vein . . . . . 5. *T. stenocarpum*
    9. Primary rachis pale, or, if dark, the secondary rachises not abruptly pale; lamina often more incised.
      10. All axes, except the primary, green-margined to base or almost so, i.e., lamina only once fully pinnate, then pinnatifid; secondary axes abaxially rounded. . . . . 2. *T. buniifolium*
      10. Lamina mostly fully bipinnate; secondary rachises, if marginate, abaxially carinate.
        11. Secondary rachises abaxially black, with two pale lateral or one pale median ridge; lamina bipinnate or almost so, with superficially crenato-lobate pinnules; pinnae not enlarged at the base . . . . . 7. *T. atratum*

\* For intermediates see 12a. *T. biserratum* (BLUME) v.A.v.R.

11. Secondary rachises abaxially various, but not black with pale ridges; lamina often bipinnate + pinnatifid.
12. Primary rachis and indusia black; ultimate lobes abaxially with very broad and prominent veins occupying  $\frac{1}{4}$ – $\frac{1}{3}$  of their width (fig. 9) . . . . . **6. *T. obtusatum***
12. Primary rachis and indusia pale to dark brown; ultimate lobes with immersed, if slightly prominent, relatively much narrower veins.
13. Indusia about twice as broad as long\*, 0.3 mm long; margin bordering the apical sorus of the segment usually denticulate; texture herbaceous . . . . . **1. *T. denhamii***
13. Indusia longer, or, if only  $\frac{1}{3}$  mm long,  $\pm$  isodiametric or longer than broad\*; margin bordering the apical sorus entire, or no apical sorus; texture firmer.
14. Larger segments pinnatifid, each lobe with a sorus overtopped by part of the lobe (fig. 6). . . . . **3. *T. amboynense***
14. Larger segments (except for the basal pinnae) crenate, each lobe with a terminal or sub-terminal sorus.
15. Secondary rachises abaxially terete in a considerable basal portion; basiscopic pinnules of basal pinnae usually enlarged and more dissected than the others (fig. 10) . . . . . **4. *T. novoguineense***
15. At least the larger secondary rachises abaxially carinate; basiscopic pinnules of basal pinnae rarely enlarged and more dissected (fig. 11) . . . . . **11. *T. luzonicum***

**1. *Tapeinidium denhamii* (HOOKER) C. CHR.** Ind. Fil. (1906) 631; KRAMER, Act. Bot. Neerl. 15 (1967) 583. — *Davallia denhami* HOOKER, Second Cent. Ferns (1861) pl. 47. — *Microlepia denhami* (HOOKER) MOORE, Ind. Fil. 2 (1861) 292. — *Lindsaea denhami* (HOOKER) METT. ex KUHN, Verh. Zool. Bot. Ges. 19 (1869) 573. — *Wibelia denhami* (HOOKER) KUHN, Chaetopt. (1882) 346. — Type: MILNE 116, Viti Levu, Fiji (K).

*T. tenuis* COPELAND, Philip. J. Sc. 60 (1936) 110, pl. 17. — Type: BRASS 3025, San Cristóval, Solomon Is. (MICH, dupl. in BISH, GH, L).

*T. tenue* auct. non (BRACKENR.) COPELAND, Bull. Bish. Mus. 59 (1929) 69; KRAMER, Blumea 15 (1968) 548; not *Microlepia tenuis* BRACKENR. U.S. Expl. Exp. (1854) 236. — **Fig. 7.**

*Rhizome* short-creeping, 1–2 mm  $\phi$ ; scales reddish brown, acicular, to  $1\frac{1}{2}$  mm long, up to 4-seriate at base, the greater part uni- or biseriate. Leaves clustered to moderately close; *petioles* stramineous to reddish or less often dark brown, abaxially obtusely or upward sharply bi-angular and then mostly pale-angled, 5–30 cm long, less than half to about as long as the lamina. *Lamina* oblong to triangular or subpentagonal, 10–35 cm long, 5–20 cm wide, in small specimens pinnate + pinnatipartite or mostly bipinnate, in larger ones tripinnate + pinnatipartite at base; primary rachis like the upper part of the petiole or abaxially subterete. *Primary pinnae* c. 12–20 to a side, laxly ascending, sessile or the basal short-petiolulate, if small and once pinnate, linear and up to c. 6 by  $1\frac{1}{2}$  cm, if larger and more compound, to 15 by 10 cm; secondary rachises stramineous, abaxially rounded or narrowed-rounded, or almost keeled. *Secondary pinnae* of at least twice pinnate leaves c. up to 20 to a side, pinnate or pinnate + pinnatifid, the basal ones of the basal primary pinnae often prolonged and then the leaf approximately pentagonal; ultimate pinnules 1–5 cm long,  $\frac{1}{3}$ –1 cm wide,

lanceolate to linear, acuminate, pinnatifid to bipinnatifid. *Ultimate segments* herbaceous, dark green or olivaceous when dry, oblique, ovate or oblong to lanceolate, decurrent and connected, obtuse or subacute, dentate to pinnatifid, size and shape depending greatly on the degree of dissection of and the place in the lamina, larger and broader in less dissected pinnules, somewhat asymmetric, without thickened margin, with evident, flexuous costa giving off single (or forked in larger lateral lobes), evident veins. Upper pinnae, secondary pinnae, and pinnules gradually reduced, confluent into pinnatifid, acute or mostly acuminate apices of lamina, pinnae, etc. *Sori* single or rarely paired on the teeth of the lobes, in most cases also on the apical one, uniserial. The soriferous vein distinctly broadened below the indusium, the margin opposite the indusium occasionally denticulate; indusium brownish, delicate, suborbicular to elongate in prolongation of its vein, 0.3–0.7 mm long, 0.4–0.8 mm wide, not quite reaching the margin and with rounded edge or with a small protracted lobe that often slightly exceeds the margin, sometimes ruptured at maturity, attached at the base and sides. Spores brownish, subellipsoidal, smooth, c. 36 by 28  $\mu$ .

Distr. Admiralty Is. (Manus), Bismarck Arch. (New Ireland, New Hannover), Solomon Is., New Hebrides, Fiji.

Ecol. Terrestrial in forests, 100–900 m, often said to be locally common.

Note. Quite variable in the degree of dissection, but the shape and especially the place of the sori is very characteristic, no other species regularly having sori on the terminal lobes.

**2. *Tapeinidium buniifolium* KRAMER, Blumea 15 (1968) 549.** — *T. moluccanum* auct. non (BLUME) C. CHR.; WAGNER & GREYER, Un. Cal. Publ. Bot. 23 (1948) 36. — Type: GREYER & WAGNER 4188, Tjajjak Mts, Mt Dremsl region, Manus,

\* For the sake of consistency with the terminology employed in *Lindsaea* the length of an indusium is measured at right angles to its vein, the width in prolongation of its vein.

Admiralty Is. (MICH; dupl. in BISH, US).

*Rhizome* only known from very short pieces, c.  $3\frac{1}{2}$  mm  $\phi$ ; scales reddish brown, to c. 1 mm (or more?) long, to  $\pm$  4-seriate at base, with long, acicular, uni- or pauciseriate apex. *Petioles* stout, rather lustrous, medium brown, crushed but apparently abaxially upward obtusely bi-angular, c. 60 cm long. *Lamina* probably 30 cm or more long (no complete leaf seen), pinnate + quadripinnatifid or subbipinnate + tripinnatifid at the base, probably deltoid; primary pinnae at least 4 to a side, the lower ones remote. Primary rachis stramineous to medium brown, abaxially apparently bi-angular. Largest *primary pinnae* oblong, with a petiolule of a few mm, c. 18 by 5 cm, with c. 12–15 major secondary pinnae to a side, these somewhat ascending; axes of higher than the first order abaxially stramineous, rounded, narrowly green-margined to base, only the basal ones unmarginated at the extreme base. Larger *secondary pinnae* c. 8–12 by 3–6 cm, elongate-triangular, with c. 10–15 segments to a side, these chartaceous, obliquely ascending, not close, lanceolate to linear, the largest  $1\frac{1}{2}$ –3 cm by 4–5 mm, deeply pinnatifid at base, at the acute apex like the smaller segments dentato-lobate. *Ultimate lobes* lanceolate-ligulate, the larger ones up to 4 by  $1\frac{3}{4}$  mm, subacute, often somewhat falcately ascending, asymmetric, with a bulge on the anterior margin where the sorus is situated, smaller lobes triangular, with subterminal sorus. Apical lobes of segments not soriferous. Veins abaxially evident at base but higher up evanescent, simple, forked in larger lobes. *Sori* uninerval; indusium brownish, pouch-shaped, narrowed at base, often with irregular free edge, 0.3–0.5 mm long and broad. Spores brownish, subellipsoidal, smooth, c. 35 by  $26\ \mu$ .

Distr. Only known from the type collection.

Ecol. In mountainside woods, c. 700 m.

3. *Tapeinidium amboynense* (HOOKER) C. CHR. Ind. Fil. (1906) 631; KRAMER, Blumea 15 (1968) 549. — *Davallia amboynensis* HOOKER, Sp. Fil. 1 (1845) 178, pl. 56 C. — *Lindsaea amboynensis* (HOOKER) METT. ex KUHN in Miq. Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 279. — *Wibelia amboynensis* (HOOKER) KUHN, Chaetopt. (1882) 346. — Type: CHR. SMITH *s.n.*, Ambon (K).

*Davallia stenoloba* BAKER in Becc. Malesia 3 (1886) 35. — *T. moluccanum* (BLUME) C. CHR. var. *stenolobum* (BAKER) C. CHR. Ind. Fil. Suppl. 3 (1934) 176. — *T. stenolobum* (BAKER) WAGNER & GREUTER, Un. Cal. Publ. Bot. 23 (1948) 36. — Type: BECCARI *s.n.*, Mt Salhutu, Ambon (FI; fragm. in K).

*T. amplum* COPELAND, Occ. Pap. Bish. Mus. 15 (1939) 82, f. 3. — Type: TAKAMATSU 1572, Garasumao, Palau Is. (MICH; dupl. in BISH, K, US).

*T. moluccanum* C. CHR. Ind. Fil. Suppl. 3

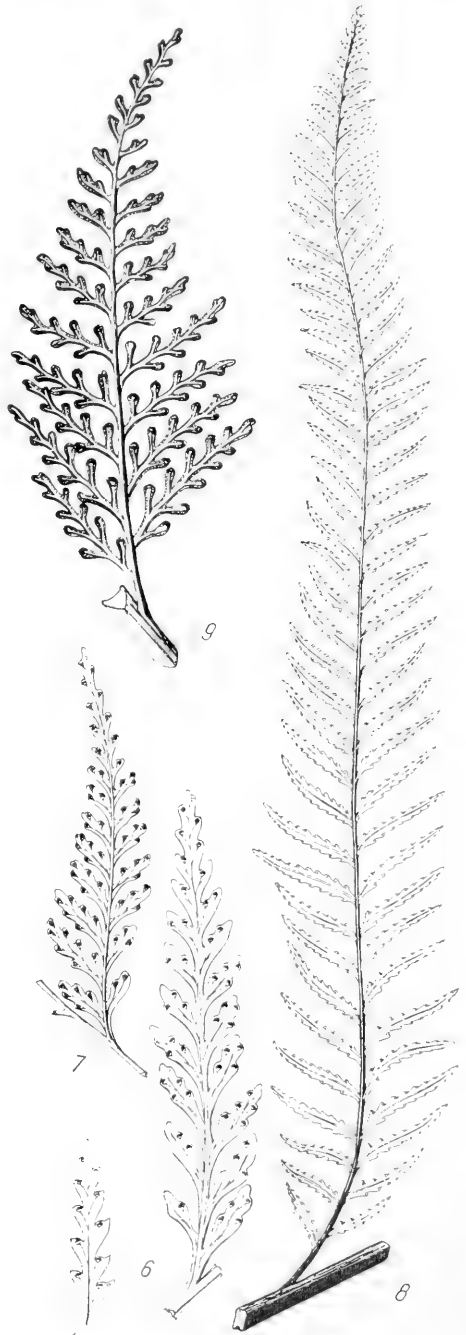


Fig. 6. *Tapeinidium amboynense* (HOOK.) C. CHR. Two pinnules from different parts of the lamina,  $\times 1\frac{1}{4}$  (DE VRIESE 358). — Fig. 7. *T. denhamii* (HOOK.) C. CHR. Pinnule,  $\times 1\frac{1}{4}$  (BRASS 3335). — Fig. 8. *T. atratum* KRAMER. Pinna,  $\times \frac{3}{4}$  (H. J. LAM 1556). — Fig. 9. *T. obtusatum* v.A.v.R. Pinna,  $\times \frac{3}{4}$  (H. J. LAM 1857).

(1934) 176, and of later authors; not *Davallia moluccana* BLUME.—Fig. 6.

*Rhizome* short- to moderately long-creeping, 3–5 mm  $\phi$ ; scales castaneous, narrowly triangular, or with ovate base and acicular apex, to 2½ mm long, 8- to 10-seriate at base, with rather long uniseriate apex. Leaves close to somewhat remote; *petioles* medium to olivaceous brown or darker with age, abaxially rounded or mostly upward obtusely or sometimes sharply bi-angular, then also sulcate and occasionally pale-angled, 25–50 cm long, as long as to twice as long as the lamina. *Lamina* oblong or elongate-deltoid, sometimes subpentagonal, c. 25–40 cm long, at the base bipinnate + pinnatifid or + bipinnatifid, sometimes pinnate + bipinnatifid, with c. 10–15 primary pinnae to a side and some strongly reduced upper ones; primary rachis abaxially rounded to obtusely or less often sharply bi-angular, not rarely sulcate. *Pinnae* ascending or the basal ones almost spreading, oblong or elongate-deltoid or the basal ones subrhombic, scarcely asymmetric but the basal basiscopic secondary pinnae often somewhat reduced, except in the basal pair where one or a few pairs of secondary pinnae are often considerably produced; largest, basal pinnae up to 15 by 10 cm, the upper ones relatively much narrower, all acuminate or caudate; upper pinnae  $\pm$  gradually reduced, confluent into a bipinnatifid-pinnatifid leaf-apex. Secondary rachises stramineous or pale brown, abaxially terete, often marginate; *secondary* and *ultimate divisions* ascending, asymmetric, with cuneate base,  $\pm$  decurrent, elongate-ovate, lanceolate, or linear, obtuse to subacute, often 1–3 cm long and 1½–5 mm wide, crenate to pinnatifid, or larger, more strongly incised, and more acute; number and size very variable, depending on the size of and the place in the lamina of the pinna; upper ones reduced, confluent. Texture chartaceous or subcoriaceous, sometimes coriaceous; colour olivaceous or brownish when dry. Costa pale, abaxially prominulous, obtuse. Veins very oblique, immersed or slightly elevated, mostly  $\pm$  evident, simple or once, or in larger lobes 2 or 3 times forked; *lobes of ultimate segments* rounded, subacute or acute, each bearing one (or the largest two) sorus, which except in the very small uppermost lobes is distinctly overtopped by part of the lobe which, if large enough, receives a branch of the vein; apex of segment not soriferous. *Sori* uninerval; indusium brown, pouch-shaped, with convex or cuneate base, attached at the base and the sides, on the marginal side sometimes protracted as a slight ridge, c. 0.4 mm long and broad, its somewhat convex free edge not reaching the margin, falling short of it by a variable distance. Spores yellowish, ellipsoidal, smooth, c. 35 by 25  $\mu$ .

*Distr. Malesia*: Celebes, Moluccas (Talaud, Morotai, Halmahera, Ternate, Ceram, Ambon), Kei Is., Waigeo, Biak, W. New Guinea, Palau Is.; doubtfully Borneo.

*Ecol.* Terrestrial in forests, from sea level to 800 m.

**4. *Tapeinidium novoguineense* KRAMER**, *Blumea* 15 (1968) 550. — Type: SCHLECHTER 14319, Torricelli Mts, Terr. of New Guinea (B; dupl. in BM, BO, K, P).—Fig. 10.

*Rhizome* moderately long- to rather short-creeping, 2–4 mm  $\phi$ ; scales medium brown, elongate-triangular, to 3 mm long, to c. 12-seriate at base, the uniseriate apex relatively short. Leaves rather close; *petioles* stout, the base often verruculose from scale bases or persistently scaly, dull, stramineous with darker base or darker throughout, abaxially terete, c. 25–75 cm long, slightly shorter than to twice as long as the lamina. *Lamina* bipinnate, or bipinnate + pinnatifid, at the base often tripinnate, elongate-triangular or subpentagonal-triangular, less often oblong, c. 20–55 cm long; primary rachis stramineous to pale brown, abaxially rounded or narrowed-rounded, keeled only near the apex. *Pinnae* 15–35 to a side (not counting the confluent upper ones), laxly ascending, lanceolate, or the basal ones broader at the base, often acropically wider at the base, shortly acuminate; *larger pinnate pinnae* 12–16 cm long, 3–5 cm wide, with c. 20–30 pinnules to a side, the basal pinnae usually with a strongly protracted basal basiscopic secondary pinna (smaller but similar ones may be present next to and opposite it, and on the second pair of pinnae) similar in shape to a middle primary pinna. Secondary (and, if any, tertiary) rachises stramineous, abaxially rounded in the lower, carinate in the upper part. *Ultimate free pinnules* c. 20–30 to a side, ascending, closely and regularly spaced but not contiguous, subcoriaceous or coriaceous, mostly olivaceous or brownish when dry, lanceolate, mostly obtuse or subacute and with narrowed, cuneate-decurrent base, the larger ones usually 3–4 cm long and 3–4 mm wide, crenate to pinnatifid to the middle (or beyond in the basal pinnae), with abaxially prominulous, pale costa. Veins simple in the lobes (crenations) or forked in the larger ones, somewhat prominulous. Lobes oblong, or  $\pm$  triangular if small, obtuse. *Upper pinnae* rather suddenly reduced, pinnatifid, then crenate, gradually simpler, confluent into a pinnatifid leaf-apex; upper pinnules (segments) also reduced and confluent. *Sori* single in the lobes, or paired or a few together in exceptionally large ones, uninerval, their vein often conspicuously broadened at the end; indusium brownish, pouch-shaped to almost triangular, entire, 0.4–0.7 mm long, 0.3–0.5 mm wide, not reaching the margin by its width or less, about equally remote from both the lateral and the apical edges of its lobe. Spores brownish, ellipsoidal, smooth, c. 35 by 24  $\mu$ , exceptionally larger.

*Distr. Malesia*: Japen I., New Guinea (all Div.); Solomon Is.

*Ecol.* In forests and thickets, 200–2100 m, often said to be locally common.

**5. *Tapeinidium stenocarpum* v.A.v.R.** *Nova Guinea* 14 (1924) 52; KRAMER, *Blumea* 15 (1968) 550.—Type: H. J. LAM 1442, mountain ridge near

Idenburg R., W. New Guinea (BO; dupl. in K, L, SING, U; fragm. in US).

*Rhizome* not very short-creeping, 2–2½ mm  $\sigma$ ; scales fuscous, elongate-triangular, to c. 3 mm long, to c. 10-seriate at base, with well-developed uniseriate apex. Leaves not close; *petioles* atropurpureous to blackish, dull, abaxially terete in the lower part, upward obtusely to subacutely bi-angular and somewhat pale-angled, c. 15–20 cm long, half as long as to as long as the lamina. *Lamina* oblong to elongate-rhombic, bipinnate + deeply pinnatifid at the base (almost tripinnate), c. 20–35 cm long; primary rachis abaxially obtusely bi-angular at the base,  $\pm$  distinctly pale-angled and often mottled, upward pale, narrowed-rounded, subcarinate near the apex. *Primary pinnae* c. 15–25 to a side, ascending, often somewhat overlapping, the basal ones c. 10–15 by 3½–4 cm, the upper ones gradually, then abruptly more strongly reduced, confluent into an acuminate pinnatifid leaf-apex. Secondary rachises abaxially pale, terete at the base, upward narrowed-rounded to subcarinate. *Pinnules* to 15–20 to a side, ascending, acute to acuminate, not contiguous, the basal basicopic ones sometimes subpinnate + pinnatifid; average pinnules deeply pinnatisect, with c. 10–12 ascending linear lobes to a side, these up to 3 by ⅔ mm, obtuse, connected by narrow, upward broader wings, the upper ones denticuliform, broadly connected and forming a lobed pinnule-apex; upper pinnules of pinnae, and pinnules of upper pinnae, less incised, lobed to entire. Pinnule costules abaxially prominent, pale, obtuse; lobes often with revolute margin, chartaceous, brown when dry, the vein immersed but evident, simple or slightly branched in the largest ones. *Sori* single in the ultimate lobes, absent from the terminal ones, uninerval, terminal in small lobes, on an acroscopic lateral bulge in larger ones; indusium narrowly pouch-shaped, 0.2–0.4 mm long, 0.3–0.7 mm wide, dark, entire, not reaching the margin by ½–1 times its width. Spores brownish, ellipsoidal, smooth, c. 35 by 25  $\mu$  (very few seen).

Distr. *Malesia*: W. New Guinea (2 coll.).

Ecol. Terrestrial in mossy forests, c. 1400–1800 m.

**6. *Tapeinidium obtusatum* v.A.v.R.** Nova Guinea 14 (1924) 52; KRAMER, *Blumea* 15 (1968) 550.—Type: H. J. LAM 1857, mountain ridge near Doormantop, W. New Guinea (BO; dupl. in L, SING, U).—Fig. 9.

*Rhizome* moderately long-creeping, 3–4 mm  $\sigma$ ; scales light castaneous, narrowly triangular, to 5 mm long, to c. 10-seriate at base, there often with laterally protruding cell-walls, with a relatively short uniseriate apex. Leaves not close; *petioles* black, dull, somewhat verruculose at base, abaxially terete or very obtusely and indistinctly bi-angular near the apex, c. 25 cm long, usually longer than the lamina. *Lamina* oblong or elongate-triangular, c. 15–25 cm long, described as lustrous on both sides when fresh, rigidly coriaceous, brown to blackish when dry, at the

base tripinnate + pinnatifid, elsewhere bipinnate + pinnatifid, with c. 10 major pinnae to a side and some reduced upper ones; primary rachis brown to black, dull, abaxially like the petiole, near the apex subcarinate. *Pinnae* ascending, the basal ones triangular, c. 8 by 5 cm, the other ones oblong, c. 5–6 by 2 cm; basal pinnae with a basicopic bipinnate + pinnatifid pinnule, otherwise the pinnae once pinnate, with the larger pinnules pinnatifid or pinnatilobate. Secondary axes dark or, especially the upper ones, pale, abaxially narrowed-rounded to subcarinate. *Larger secondary pinnae* with 5–8 segments on a flexuous costa, the segments alternate, linear-subspathulate, oblique, not close, decurrent, joined by narrow wings, the margin subrevolute, often 2–4 by 1 mm, with a broad, abaxially much elevated, obtuse, stramineous costule that occupies about ⅓ of its width and is often conspicuously broadened under the sorus. Apex of lobes obtuse, in the larger ones slightly oblique. *Sori* single (rarely paired) and apical in the lobes, uninerval; indusium dark, rigid, in larger lobes somewhat oblique on the vein, with  $\pm$  straight base and convex free edge, adnate at the sides, ½–1 mm long, ½ mm wide, not quite reaching the margin. Spores medium brown, ellipsoidal, smooth, 60 by 45  $\mu$ .

Distr. Only known by the type collection.

Ecol. Terrestrial in mossy forest, c. 2500 m.

**7. *Tapeinidium atratum* KRAMER**, *Blumea* 15 (1968) 551.—Type: H. J. LAM 1556, mountain ridge near Doormantop, W. New Guinea (BO, 2 sh.; dupl. in L, SING, U).—Fig. 8.

*Rhizome* not short-creeping, c. 2 mm  $\sigma$ ; scales reddish brown, narrowly triangular, to 2 mm long, to c. 8-seriate at base, with a long uni-biseriate apex. *Petioles* stout, 4–5 mm  $\sigma$  at base, almost black, sublustrous, basally verruculose, abaxially sharply bi-angular above, downward gradually rounded, not pale-margined, to 60 cm long, about as long as the lamina. *Lamina* oblong, bipinnate, with c. 15–20 remote but ascending and often  $\pm$  touching pinnae to a side; primary rachis blackish, abaxially sharply bi-angular, upward pale-margined and  $\pm$  sulcate. *Pinnae* narrowly deltoid, shortly acuminate, c. 20 by 2½–3 cm, basicopically slightly narrowed at the base, pinnate, upward pinnatifid; secondary rachises dark, abaxially with one median or two lateral pale ridges. Upper pinnae gradually reduced, confluent into a pinnatifid leaf-apex. *Pinnules* up to c. 35 to a side, rigidly coriaceous, brown when dry, about twice their width apart, somewhat ascending, very narrowly lanceolate, the largest c. 17 by 4 mm, pinnatilobate, with c. 9 lobes to a side, these broadly rounded, to 1 by 1 mm; apex obtuse; base cuneate, decurrent. Costa pale, abaxially prominent, obtuse, flexuous towards the apex; veins hidden, simple or once forked. Upper pinnules reduced, confluent. *Sori* 1, less often 2 or 3 per lobe, near the anterior margin, just inside the apex, uninerval; indusium blackish, pouch-shaped, 0.3–0.5 mm long, 0.3–0.4 mm wide,



attached at the sides, not reaching the margin by little less than its width. Spores brownish, ellipsoidal, smooth, *c.* 35 by 25  $\mu$ .

Distr. Only known by the type collection.

Ecol. Collected at 1420 m.

**8. *Tapeinidium gracile* (BLUME) v.A.v.R.** Handb. (1908) 315; KRAMER, *Blumea* 15 (1968) 551.—*Davallia gracilis* BLUME, En. Pl. Jav. (1828) 233.—*Microlepia gracilis* (BLUME) J. SMITH, Lond. J. Bot. 1 (1842) 427.—*Wibelia gracilis* (BLUME) CHRIST, Ann. Jard. Bot. Btzg II, 5 (1905) 134.—Type: BLUME 1731 or *s.n.*, Java (L).

? *Dicksonia linearis* CAV. Descr. (1802) 274.—Type: NÉE *s.n.*, Philippines (MA, *n.v.*).

**Rhizome** rather short- to rather long-creeping, *c.* 2 mm  $\phi$ ; scales reddish brown, narrowly triangular, to 2½ mm long, to *c.* 6-seriate at base, with a long uniseriate apex. Leaves close to *c.* 1 cm apart; *petioles* slender, ⅔–1 mm  $\phi$  at apex, reddish brown to atropurpureous, at least upward pale-margined, abaxially sharply bi-angular, the base usually subterete, *c.* 10–35 cm long. **Lamina** oblong, *c.* 12–30 cm long, *c.* 2–3 times as long as wide, to 1½ times as long as the petiole, rarely shorter, pinnate + pinnatifid, less often at the base pinnate + pinnatilobate; rachis abaxially at the base dark and pale-angled, the two abaxial angles of the petiole merging into one near the basal pinnae to form a sharp keel on the rachis, the upper part quite pale. **Larger pinnae** *c.* 10–15 to a side, somewhat ascending, about their width apart, lanceolate to linear, the largest *c.* 8–15 cm long, (½–)1¼–3 cm wide, subsessile, acuminate; lowest pinnae the longest, the upper ones gradually and strongly reduced, confluent into a pinnatifid leaf-apex. Texture chartaceous or subcoriaceous or sometimes coriaceous, colour medium green or brownish when dry. **Lower pinnae** pinnatilobate to the middle (rarely less) to deeply pinnatifid to a narrow costal wing, the lobes asymmetrically triangular and serrate or crenate if short, linear, obtuse, subentire to crenate if larger, ascending, occasionally somewhat falcate, often 12–15 major ones to a side in the larger pinnae, to 2½ by 3 mm; **basal basiscopic segments** of most pinnae reduced, those opposite them often somewhat prolongate. Costae of pinnae pale, abaxially acute, of segments pale, flat, both abaxially prominent. **Upper segments** strongly reduced, most pinnae with a long pinnatilobate-crenate apex. Veins hidden, ascending, simple or rarely once forked. **Sori** uninerval, on the lateral and not rarely also on the terminal veinlets of the segments, separated by crenations; indusium pouch-shaped,  $\pm$  semi-elliptic, with straight or slightly lobed edge, ⅓–½ mm long and broad, mostly falling from the apex of its lobule by its width or more, the margin sometimes revolute and touching it when dry. Spores pale brownish, subellipsoidal to bean-shaped, smooth, 34–36 by 24–28  $\mu$ .

Distr. E. Annam; in *Malesia*: W. Java, Bali, Sarawak, Brunei, Celebes, Ceram, Philippines.



Map 1. Distribution of *Tapeinidium gracile* (BL.) v.A.v.R.

The only species with a notably disjunct area. Map 1.

Ecol. Terrestrial and epilithic, in forests, 500–1300 m.

**9. *Tapeinidium calomelanos* KRAMER**, *Blumea* 15 (1968) 551.—Type: KORTHALS *s.n.*, G. Sakumbang, SE. Borneo (L, 2 sh.).

**Rhizome** short- to somewhat more long-creeping, 2–3 mm  $\phi$ ; scales castaneous, elongate-triangular, to *c.* 2 mm long, to *c.* 6-seriate at base, long-acuminate. Leaves close to 1 cm apart; *petioles* very dark purplish brown, dull or shining, 1–2 mm  $\phi$  at apex, abaxially terete, 10–35 cm long, mostly shorter than the lamina. **Lamina** elongate-triangular to oblong or subpentagonal, 10–35 cm long, pinnate + deeply pinnatifid, or at the base bipinnate (+ pinnatifid), subcoriaceous or coriaceous, olivaceous-brown when dry. Primary rachis atropurpureous or dark castaneous, abaxially terete. **Pinnae** ascending, *c.* 12–20 major ones to a side, lanceolate, the lower ones usually triangular, subsessile, often somewhat overlapping, acuminate, the larger ones deeply pinnatifid or occasionally pinnate at the base and then sometimes the largest basiscopic pinnules pinnatifid, to *c.* 15 by 2½ cm; **major pinnules** (segments) to 18 to a side, lanceolate, ascending, 30 by 2½ cm to 8 by 7 mm, or larger if incised, otherwise serrate or crenate, unequally cuneate at the base, obtuse or subacute, rapidly decreasing in size to the pinna-apex; secondary (and, if any, tertiary) rachises abruptly pale (except sometimes those of the lowest pinnae), abaxially terete. **Upper pinnae** crenate, confluent into a pinnatifid leaf-apex. Veins immersed, hidden, or slightly elevated, simple, or forked in the larger lobes. **Sori** uninerval, slightly immersed, single in the lobes of the ultimate segments, the margin opposite the indusium sometimes notched; indusium dark, 0.3–0.6 mm long, 0.3 mm wide, mostly longer than wide, not reaching the margin by its width or more. Spores brownish, ellipsoidal, smooth, *c.* 35 by 26  $\mu$ .



Distr. *Malesia*: Sumatra (?), Borneo, Celebes, Philippines (Luzon).

Ecol. One record from moist shady forest, c. 140 m.

**10. *Tapeinidium oligophlebium* (BAKER) C. CHR.** Ind. Fil. (1906) 631; KRAMER, *Blumea* 15 (1968) 552. — *Davallia oligophlebia* BAKER, J. Bot. 26 (1888) 323. — *Wibelia oligophlebia* (BAKER) CHRIST, Ann. Jard. Bot. Btzig II, 5 (1905) 134. — Type: HOSE 220, Laupi, Sarawak (K).

*Protolindsaya brooksii* COPELAND, Philip. J. Sc. 5 (1910) Bot. 283. — *T. brooksii* (COPELAND) C. CHR. Ind. Fil. Suppl. 3 (1934) 176. — Type: BROOKS 47, G. Bengkaim, Sarawak (SAR, holotype?; dupl. in BM).

*Rhizome* short-creeping,  $\frac{2}{3}$ –2 mm  $\sigma$ ; scales light brown, lanceolate to elongate-triangular, to  $1\frac{1}{2}$  mm long, to c. 6-seriate at base, the uniseriate apex comparatively short. Leaves close; *petioles* slender, stramineous with darker base or brown throughout, abaxially bi-angular, 2–10 cm long. *Lamina* narrowly lanceolate to triangular, about as long as to 5 times as long as wide,  $2\frac{1}{2}$ –12 cm long, with c. 6–20 pinnae to a side; rachis abaxially bi-angular at the base, the angles fusing, mostly between the two basal pairs of pinnae, to form one keel. *Pinnae* slightly ascending or the basal ones spreading, ovate and crenate to linear and then usually pinnatifid to pinnatifid, or the basal ones fully pinnate, with crenate pinnules; size and shape of pinnules strongly dependent on the degree of dissection of and the place in the lamina; larger pinnules often c. 2 mm wide, mostly obtuse. Upper pinnae and pinnules gradually reduced, confluent. Texture herbaceous to subcoriaceous, colour usually brownish or olivaceous when dry. *Secondary rachises* (costae) abaxially carinate, costae of smaller divisions usually rounded and obsolescent above the base. Veins immersed, abaxially  $\pm$  evident. *Sori* uninerval, single or a few together on the lateral lobes of the larger segments, in larger lobes sometimes overtopped by a sterile part of the lobe, otherwise subterminal; indusium  $\frac{1}{4}$  mm broad,  $\frac{1}{4}$ – $\frac{1}{2}$  mm long, brownish, subentire, pouch-shaped, not reaching the margin by its width or more, sometimes ruptured at maturity. Spores brownish, ellipsoidal, smooth, c. 35 by 25  $\mu$ .

Distr. *Malesia*: Borneo (Sarawak, Kalimantan).

Ecol. Terrestrial, in forests and on shaded cliffs, c. 700–1000 m.

Note. The specific distinctness of this taxon is doubtful. It may be a reduced variety or form of another species, e.g. *T. luzonicum*.

**11. *Tapeinidium luzonicum* (HOOKER) KRAMER,** *Blumea* 15 (1968) 552. — *Davallia luzonica* HOOKER, Sp. Fil. 1 (1845) 174, pl. 60 B. f. 2, 3, 5. — *Wibelia bipinnata* FÉE, Gen. Fil. (1852) 331, nom. subfl. — Type: CUMING 139, p.p., Luzon (dupl. in B, GH, L).

*Lindsaea pinnata* (CAV.) METT. ex KUHN var.

*bipinnata* METT. ex KUHN in Miq. Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 279. — Type: ZOLLINGER 1305, Java (dupl. in HBG, L).

*Davallia philippinensis* HARRINGTON, J. Linn. Soc. Lond. 16 (1877) 27. — *Microlepia philippinensis* (HARRINGTON) COPELAND, Polypod. Philip. (1905) 56. — *T. philippinense* (HARRINGTON) C. CHR. Ind. Fil. Suppl. 3 (1934) 176. — Type: STEERE s.n., Mt Mahayhay, Luzon (K).

*Davallia hosei* BAKER, J. Bot. 26 (1888) 323. — Type: HOSE 219, Lambur, Sarawak (K).

*T. sumatranum* v.A.v.R. Bull. Jard. Bot. Btzig III, 2 (1920) 174. — Type: BROOKS 332/S, Bencoolen, Sumatra (BM; fragm. in BO).

*T. biserratum* auct. non (BLUME) v.A.v.R.; HOLTUM, Rev. Fl. Mal. 2 (1954) 339, f. 197; and of other authors. — Fig. 11.

*Rhizome* usually short-creeping, to 4 mm  $\sigma$ ; scales golden brown, narrowly triangular, long-acuminate, to 4 mm long. *Petioles* about as long as to twice as long as the lamina, abaxially terete at the base, in the upper half or less often only near the apex obtusely to acutely bi-angular, flat or usually sulcate. *Lamina* oblong, narrowly oblong, triangular, or occasionally subpentagonal, at least once pinnate + pinnatifid. Primary rachis stramineous or pale brown, abaxially sharply carinate. Secondary rachises (costae) abaxially elevated, sharply carinate, pale. Upper pinnae and pinnules (segments) gradually reduced, confluent. *Sori* uninerval. Spores pale brown, ellipsoidal, smooth, c. 40 by 28  $\mu$ .

#### KEY TO THE VARIETIES

1. Petiole less than 1 mm  $\sigma$  at base of lamina; lamina subtripinnate at the base

##### 1. var. *leptophyllum*

1. Petiole over 1 mm  $\sigma$  at base of lamina; lamina pinnate + deeply pinnatifid or bipinnate

##### 2. var. *luzonicum*

1. Petiole sometimes less than 1 mm  $\sigma$  at base of lamina; lamina pinnate, the pinnae not incised beyond  $\frac{2}{3}$  of their width

##### 3. var. *thelypteroides*

1. var. *leptophyllum* KRAMER, *Blumea* 15 (1968) 553. — Type: ELMER 14103, Mt Urdaneta, Mindanao (L; dupl. in BM, BO, HBG, MICH).

*Rhizome* scales to 7-seriate at base. *Petioles* close, slender, at the most 1 mm  $\sigma$  at the base of the lamina, often medium brown. *Lamina* almost tripinnate, i.e. the tertiary divisions there almost free; ultimate free or nearly free divisions linear, obtuse, 1–2 mm wide, mostly not over 1 cm long; texture chartaceous, colour olivaceous or brownish when dry. Veins  $\pm$  evident, mostly simple in the lobes, these usually regularly rounded; indusium c. 0.3 mm long and broad. Otherwise like var. *luzonicum*.

Distr. *Malesia*: Philippines (Luzon, Negros, Mindanao, Panay, Leyte).

Ecol. No data.

Note. In appearance not unlike *Pityrogramma*

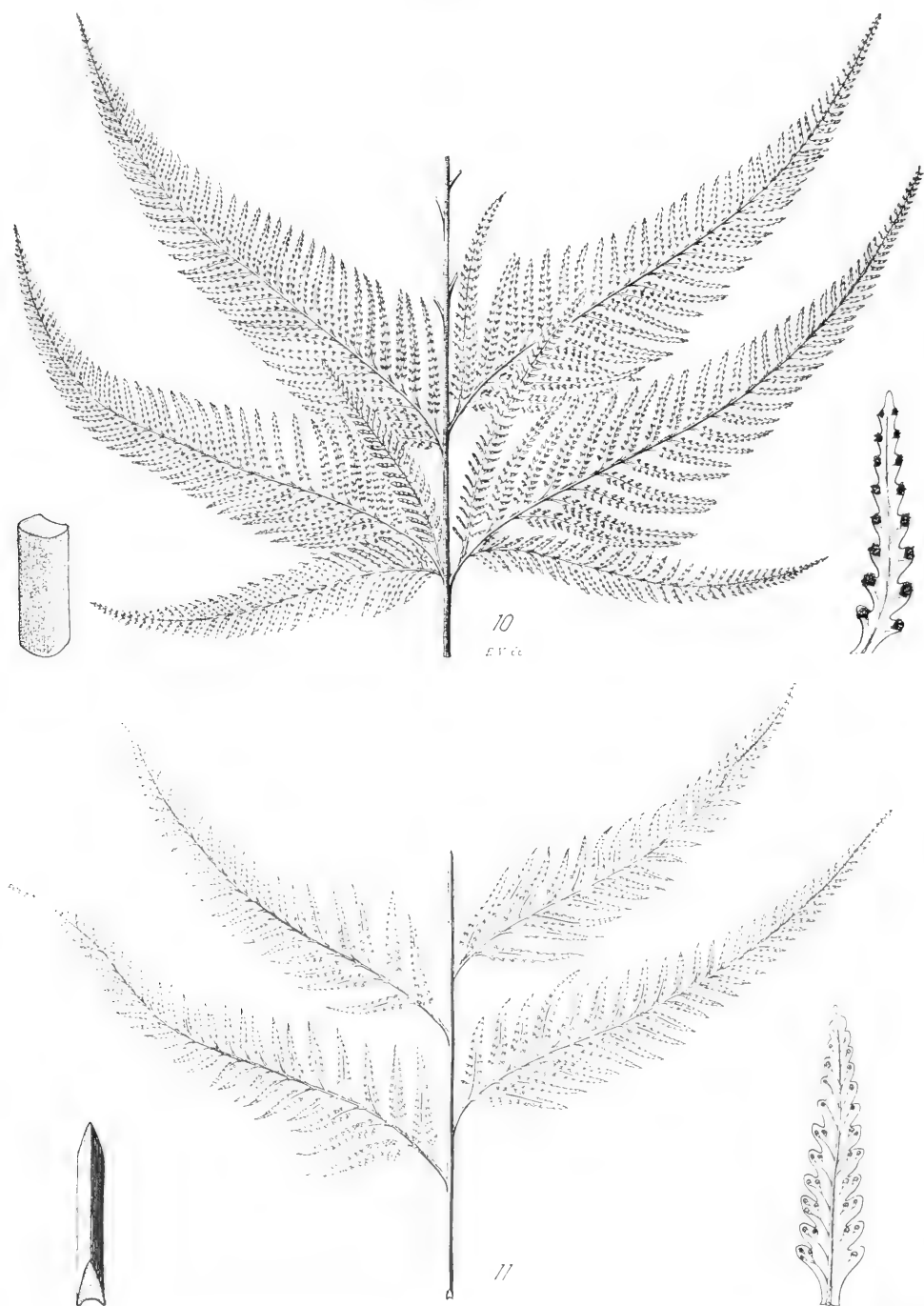


Fig. 10. *Tapeinidium novoguineense* KRAMER. Basal part of lamina,  $\times \frac{2}{5}$ , pinnule,  $\times 2$ , portion of rachis,  $\times 3\frac{1}{4}$  (v. ROYEN & SLEUMER 6394).—Fig. 11. *T. luzonicum* (HOOK.) KRAMER var. *luzonicum*. Basal part of lamina,  $\times \frac{2}{5}$ , pinnule,  $\times 2$ , portion of rachis,  $\times 3\frac{1}{4}$  (SAN 24071).

*calomelanos* (L.) LINK; also resembling *T. denhamii*, from which it differs, i.e., by the rounded, not dentate, soriferous lobes, the structure of the axes, and the firmer texture.

## 2. *var. luzonicum*.—Fig. 11.

*Rhizome* often not short-creeping, the *petioles* up to a few cm apart, stramineous to pale sordid brown, concolorous, c. 20–65 cm long, 1½–2 mm ø at the base of the lamina. *Lamina* 18–50 cm long, 8–30 cm wide, up to 4 times as long as wide, but mostly shorter, coriaceous, less often chartaceous, dark brownish or olivaceous when dry, pinnate + deeply pinnatifid, or at the base bipinnate + pinnatifid. *Major pinnae* c. 6–12 to a side, spreading or ascending, 10–20 cm long, their shape and width very variable, depending on the degree of dissection, linear and 1–2 cm wide if pinnatifid, triangular and to 12 cm wide if pinnate + pinnatisect, acuminate, with long serrato-crenate apex. *Basal basiscopic divisions* of pinnae mostly somewhat reduced, those opposite them not distinctly enlarged, if more dissected than pinnate + pinnatifid, only rarely with one basiscopic or a pair of basal enlarged, more incised secondary pinnae (as in *T. novoguineense*). *Ultimate free* (or almost free) *divisions* ascending, variable in size and shape, often 1½–2½ cm long, 1–4 mm wide, mostly obtuse or subacute, or the longest acute or shortly acuminate, shallowly crenate to pinnatifid, margin often ± revolute when dry; small segments with only the anterior margin crenate. Veins immersed, not evident, simple, or in the largest segments with a few branches. *Sori* often slightly immersed; indusium dark, rather rigid, pouch-shaped, ½–½ mm wide, ½–¾ mm long, the free edge entire, convex, not reaching the margin by about its width, sometimes the exterior lateral margin protracted as a ridge on the leaf-tissue.

*Distr.* Thailand, in *Malesia*: Malay Peninsula, Natuna and Lingga Is., Banka, Sumatra, W. Java, Borneo, Celebes, Philippines (Luzon, Mindanao, Polillo).

*Ecol.* Terrestrial in moist forests, mostly 600–1500 m, occasionally to 2200 and down to 100 m. Often said to be locally common, but rare in Java.

*Note.* See under 12a. *T. biserratum*.

3. *var. thelypteridoides* KRAMER, *Blumea* 15 (1968) 553.—Type: BROOKE 8190, Mt Santubong, Sarawak (L; dupl. in SING, US).

*Rhizome* short-creeping, with relatively narrow scales; *petioles* clustered, 10–27 cm long, not rarely less than 1 mm ø at base of lamina. *Lamina* to c. 40 by 20 cm, chartaceous, rather pale green when dry, pinnate + pinnatifid; *pinnae* to 15 cm long and 12 mm wide, very regularly pinnatifid, the lowest to ⅓, the upper ones gradually less, serrate, then subentire; segments oblong-ligulate, ascending, the largest c. 12 by 3 mm, obtuse, shallowly crenate-serrate; pinnae basally on the posterior margin shortly narrowed. Veins evident. *Sori* often more distinctly intramarginal.

Otherwise like less compound forms of *var. luzonicum*.

*Distr.* *Malesia*: Borneo (Sarawak, Sabah) (4 coll.).

*Ecol.* On rocks in forest, 400–1300 m.

12. *Tapeinidium pinnatum* (CAV.) C. CHR. Ind. Fil. (1906) 631; HOLTUM, Rev. Fl. Mal. 2 (1954) 339, f. 196; COPELAND, Fern Fl. Philip. 1 (1958) 114; KRAMER, *Blumea* 15 (1968) 553.—*Davallia pinnata* CAV. Descr. (1802) 277, non METT. ex KUHN (1869).—*Saccoloma pinnatum* (CAV.) PRESL, Tent. Pterid. (1836) 126.—*Microlepia pinnata* (CAV.) J. SMITH, Hook. J. Bot. 3 (1841) 416.—*Wibelia pinnata* (CAV.) BERNHARDI ex FÉE, Gen. Fil. (1852) 331, pl. 27 bis B.—*Lindsaea pinnata* (CAV.) METT. ex KUHN in Miq. Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 279.—Type: NÉE s.n., Philippines (also incorr. cited 'Chile') (MA, n.v.; phot. seen).

*Davallia flagellifera* HOOKER & GREVILLE, Ic. Fil. (1831) pl. 183.—Type: WALLICH s.n., Pulu Penang (n.v.).

*Davallia serrata* ROXB. ex GRIFF. Calc. J. Nat. Hist. 4 (1844) 514, non WILLD. (1810).—Type: ROXBURGH s.n., Pulu Penang (n.v.).

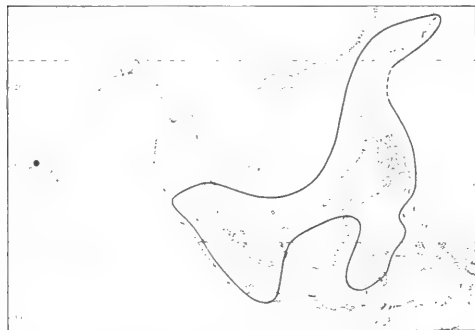
*Wibelia javae* FÉE, Gen. Fil. (1852) 331.—Type: KOLLMANN s.n., Java (n.v.).

*Davallia firmula* BAKER, Ann. Bot. 8 (1894) 123.—*Microlepia firmula* (BAKER) C. CHR. Ind. Fil. (1906) 426.—*Tapeinidium firmulum* (BAKER) C. CHR. Ind. Fil. Suppl. 3 (1934) 176.—Type: HANCOCK 72, Barisan Range, Sumatra (K).

*Rhizome* short- to rather short-creeping, 2–3 mm ø; scales castaneous, with an oval basal and a long acicular uni-biseriate apical part, to c. 10-seriate at base, to 4 mm long. *Leaves* clustered to 1 cm apart; *petioles* stramineous to medium brown, mostly darker at base, or rarely quite dark, in adult plants 1–2 mm ø at base of lamina, abaxially at least in the upper half obtusely or more often acutely bi-angular, c. 10–35 cm long, ½–⅔ the length of the lamina. *Lamina* oblong, acuminate, simply pinnate, c. 15–75 cm long, with c. 12–30 major pinnae to a side; rachis stramineous to pale brown, abaxially sharply carinate, the keel starting at the base through coalescence of the two angles on the petiole. *Pinnae* coriaceous, mostly olivaceous-brown when dry, ascending, sessile, narrowly lanceolate to linear, shortly and somewhat unequally cuneate at the base, subacute to acuminate, the basal ones remote, slightly or not reduced, the upper ones gradually closer but usually at least their width apart, gradually, then just below the pinnatifid leaf-apex suddenly more strongly reduced, the terminal lobe often caudate. *Major pinnae* 7–22 cm long, 0.3–0.8 cm wide, shallowly serrate or more often crenate or bicrenate when fertile, serrate or biserrate when sterile, with strongly ascending teeth; costa percurrent, abaxially elevated, stramineous, acute. Veins immersed, mostly hidden, once or twice forked, oblique. *Sori* uninerval (rarely on two adjacent vein-ends), on the acroscopic vein-branch and then

single, or on both branches, and then paired in the lobes, scarcely or not embossed. Indusium dark, subentire, pouch-shaped, ovate to transversely elongate-semi-elliptic, 0.3–1 mm long, 0.3–0.5 mm wide, falling short of the margin by its width or more. Spores medium brown, subellipsoidal to bean-shaped, smooth, *c.* 35 by 25  $\mu$ .

Distr. S. India, Thailand, Ryu Kyu Is., Taiwan; in *Malesia*: Malaya, Singapore, Riouw and Lingga Is., Banka, Sumatra, W. Java, Borneo, Celebes, Philippines. Reports from elsewhere due to confusion with *T. longipinnulum* and *T. melanesicum*. Map 2.



Map. 2 Distribution of *Tapeinidium pinnatum* (Cav.) C. CHR.

Ecol. In moist forests, often by or on rocks in streams, 50–2700 m, mostly between 500 and 1000 m. Apparently a facultative rheophyte.

Notes. Juvenile plants have relatively broader, serrate pinnae, but apart from their size they are similar to adult ones.

In Luzon there is a form with dark, often pale-margined petiole and abaxially narrowed-rounded rather than carinate rachis; the pinnae are smaller and narrower than in the typical form which is much more common on the island. A fairly uniform series of this form, JACOBS 7852 (L), would seem to indicate that it is more than an accidental, phenotypic form; but it is neither very strongly nor very sharply distinct from typical *T. pinnatum* and therefore left unnamed.

**12a. *Tapeinidium biserratum* (BLUME) v.a.v.R.** Handb. Suppl. (1917) 509; KRAMER, *Blumea* 15 (1968) 554; not of HOLTUM, *Rev. Fl. Mal.* 2 (1954) 339.—*Davallia biserrata* BLUME, *En. Pl. Jav.* (1828) 232.—*Microlepia biserrata* (BLUME) PRESL, *Epimel. Bot.* (1851) 97.—Type: BLUME *s.n.*, Java (L.).

The type of this 'species' is intermediate between *T. luzonicum* and *T. pinnatum*; there are 25–30 other intermediates. Their status is not clear; see KRAMER, *l.c.* They occur throughout the common range of the two species.

**13. *Tapeinidium prionoides* KRAMER, *Blumea* 15 (1968) 554.**—Type: BÜNNEMEIJER 1910, G. Siang, Banka (L; dupl. in BO).—Fig. 13.

*Rhizome* rather short-creeping, *c.* 3–4 mm  $\sigma$ ;

scales fuscous, elongate-triangular, long-acuminate, to 3 mm long, to *c.* 8-seriate at base, the uniseriate apex rather short. Leaves close; *petioles* dark stramineous to castaneous, dull, abaxially (mostly obtusely) bi-angular, upward usually pale-edged, *c.* 10–45 cm long,  $\frac{2}{3}$ –1½ times the length of the lamina. *Lamina* simply pinnate, oblong, with *c.* 10–18 free pinnae to a side and a pinnatifid, basally hastate leaf-apex; rachis stramineous to dark, abaxially narrowed-rounded or sometimes carinate, at the base often shortly bi-angular. *Pinnae* coriaceous, dark olivaceous above when dry, ascending, linear, subacute to acuminate, *c.* 10–20 cm long, 4–6 mm wide, unequally cuneate at the base, the margin serrate; teeth ascending,  $\frac{1}{2}$ –1 mm long, acute when sterile,  $\pm$  obtuse if soriferous, the basal acroscopic tooth often larger and slightly auricle-like. Costa stout, percurrent, mostly pale, abaxially strongly elevated, rounded to subacute; veins abaxially  $\pm$  prominulous, close, very oblique, once forked, the anterior branches running to the marginal teeth, or when fertile often both branches bearing a sorus on their connivent ends. *Upper pinnae* rather suddenly reduced. *Sori* placed in the teeth, uni- or occasionally binerval; indusium darkish, entire,  $\frac{1}{2}$ –1 mm long,  $\frac{1}{2}$  mm wide, almost reaching the margin. Spores light brown, ellipsoidal, smooth, *c.* 36 by 28  $\mu$ .

Distr. *Malesia*: Anambas, Riouw, and Lingga Is., Banka.

Ecol. In forests, sometimes on rocks in streams, 200–300 m.

**14. *Tapeinidium acuminatum* KRAMER, *Blumea* 15 (1968) 554.**—Type: ESCRITOR 21173, Palanan Bay, Luzon (L; dupl. in BO, BRI, GH, MICH, SING, US).—Fig. 14.

*Rhizome* rather short-creeping, 2–3 mm  $\sigma$ ; scales castaneous, lanceolate, long-acuminate, to 2½ mm long, to *c.* 10-seriate at base. Leaves close; *petioles* dark castaneous or atropurpureous, abaxially at least upward sharply bi-angular and pale-angled, *c.* 25 cm long, about as long as the lamina. *Lamina* oblong, simply pinnate, with 8–12 pinnae to a side and a conform terminal one; rachis like the upper part of the petiole or paler. *Pinnae* coriaceous, brown when dry, ascending, very narrowly lanceolate, acuminate, 10–15 cm long, 6–7 mm wide, unequally cuneate at the base, the margin shallowly and evenly crenate or sometimes biconcate. *Upper pinnae* somewhat reduced; terminal pinna conform, smaller than the larger lateral ones. Costa prominent on the abaxial side, pale, flattish; veins immersed, not evident, close, very oblique, once forked, sometimes the posterior branch forked again. *Sori* uninerval, laminal or partly extending onto the largest lobes; indusium brown, subentire,  $\frac{1}{4}$  mm wide,  $\frac{1}{2}$ –¾ mm long, with convex free edge and  $\pm$  convex base,  $\frac{1}{4}$  mm or farther from the margin. Sporangia strongly protruding at maturity. Spores abortive.

Distr. Beside the type two doubtful collections from Sabah.

Ecol. No data.

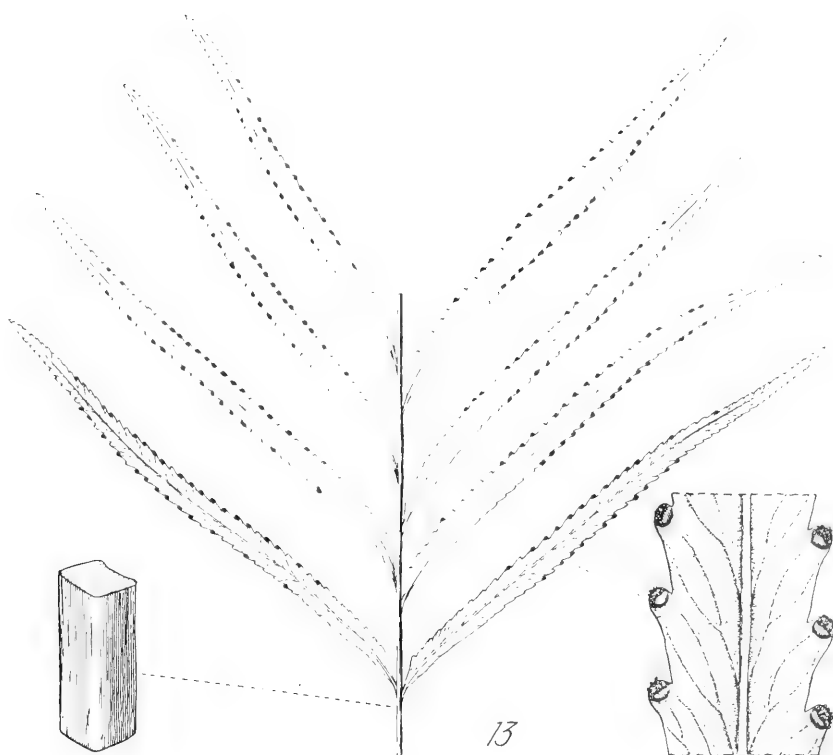
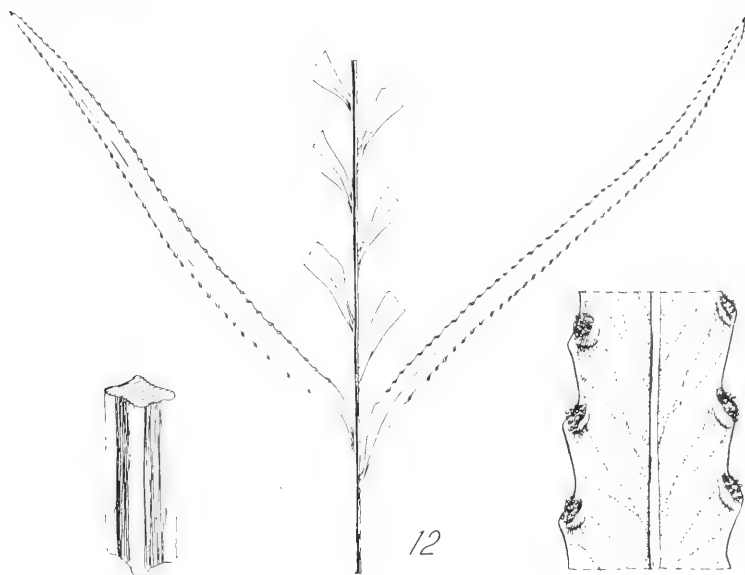


Fig. 12. *Tapeinidium longipinnulum* (CESATI) C. CHR. Basal part of lamina,  $\times \frac{1}{2}$ , portion of pinna,  $\times 3$ , portion of rachis,  $\times 5$  (BAMLER Ros. 115).—Fig. 13. *T. prionoides* KRAMER. Basal part of lamina,  $\times \frac{1}{2}$ , portion of pinna,  $\times 3$ , portion of rachis,  $\times 5$  (BÜNNEMEIJER 1910).

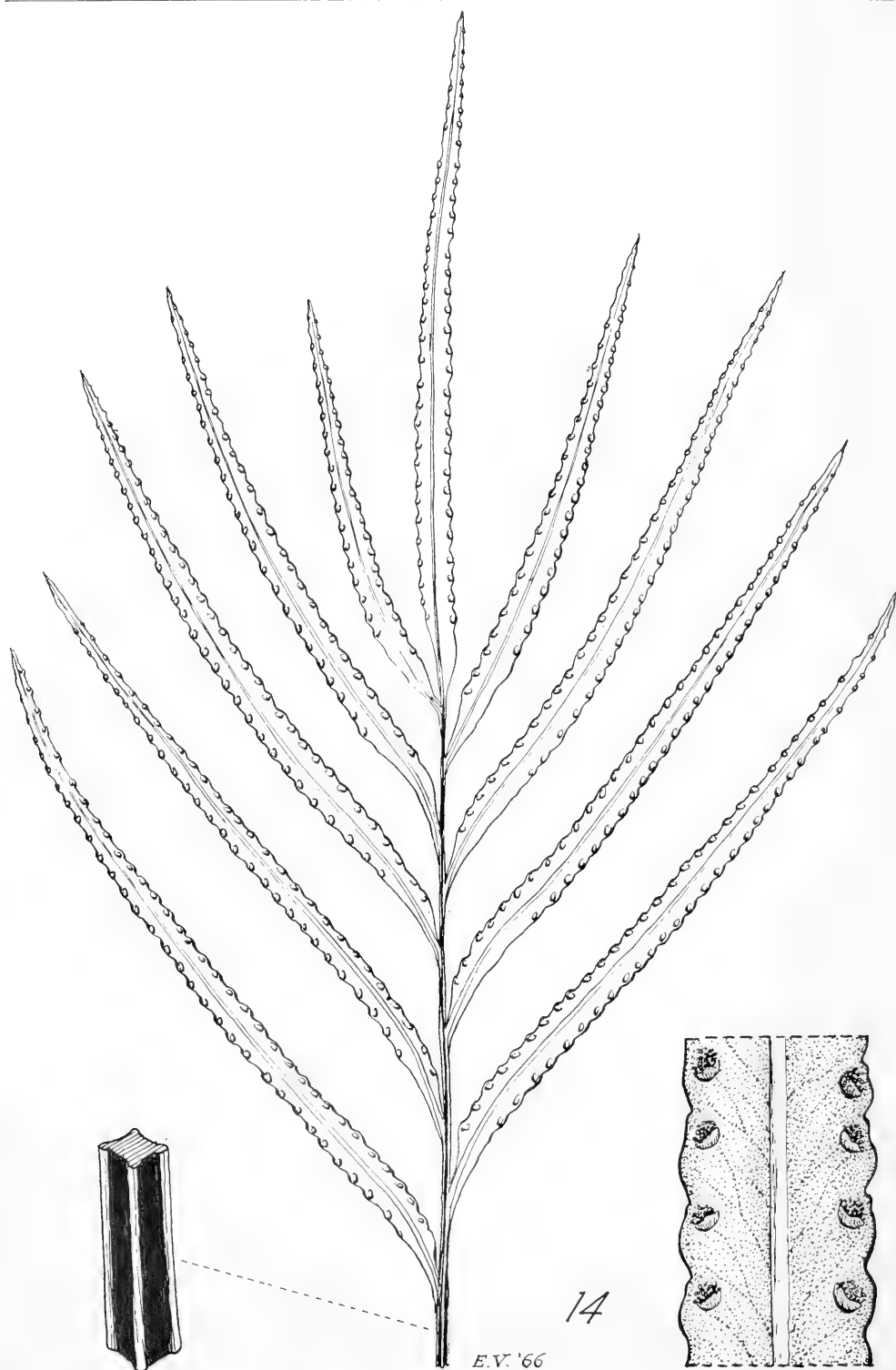


Fig. 14. *Tapeinidium acuminatum* KRAMER. Upper part of lamina,  $\times \frac{1}{2}$ , portion of pinna,  $\times 3$ , portion of rachis,  $\times 5$  (ESCRITOR 21173).

**15. *Tapeinidium longipinnulum*** (CESATI) C. CHR. Ind. Fil. Suppl. 3 (1934) 176; COPELAND, Philip. J. Sc. 78 (1949) 23; KRAMER, Blumea 15 (1968) 555.—*Davallia longipinnula* CESATI, Rendic. R. Accad. Sci. Fis. Mat. Napoli 16 (1877) 26; BECCARI, Malesia 3 (1886) 35.—Type: BECCARI *s.n.*, Ramoi, New Guinea (FI).

*Davallia intramarginalis* CESATI, Rendic. R. Accad. Sci. Fis. Mat. Napoli 16 (1877) 29.—Type: BECCARI *s.n.*, Mt Arfak, New Guinea (FI).

*T. marginale* COPELAND, Philip. J. Sc. 6 (1911) Bot. 82.—Type: KING 283, Papua (MICH; dupl. in P).—Fig. 12.

*Rhizome* rather short-creeping, 4–6 mm  $\sigma$ ; scales dark castaneous, elongate-triangular, to 5 mm long, to *c.* 16-seriate at base, the uniseriate apex very short. Leaves close to more remote; *petioles* dark castaneous to blackish, dull, quadrangular, upward sharply so and often sulcate,  $\pm$  distinctly pale-angled, 10–50 cm long, shorter than the lamina. *Lamina* oblong, simply pinnate, 30–65 cm long, 15–25 cm wide, with 8–20 pinnae to a side and a conform terminal one; rachis similar to the petiole, sulcate, upward paler and narrowly marginate. *Pinnae* alternate or the lower ones opposite, ascending, coriaceous, olivaceous to fuscous when dry, sessile or the lower ones with a short stalk-like base, linear, the largest 10–25 cm long, 7–10 mm wide, widest a little above the base, long-acuminate, unequally cuneate at the base; lower pinnae not rarely slightly reduced, the terminal pinna conform, with unequal base, occasionally with 1 or 2

reduced pinnae at its base. *Margin* of sterile pinnae serrate or biserrate, of fertile ones serrate, the teeth strongly ascending, broadly truncate, posteriorly rounded, each bearing a sorus; basal acroscopic tooth not rarely somewhat larger. Costa percurrent, abaxially elevated and rounded, stramineous. Veins often hidden, rather oblique, once forked or the anterior branch forked again, *c.* 1 mm apart, almost reaching the margin. *Sori* uni- or binerval (rarely trinerval), the upper ones most often binerval; indusium brownish, entire, semi-elliptic,  $\frac{1}{2}$ –2, most often  $\frac{2}{3}$ –1 mm long, *c.*  $\frac{1}{3}$  mm wide, very nearly equaling the margin, often strongly bulging at maturity. Spores brownish yellow, oblong, smooth, 30–35 by 24–26  $\mu$ .

Distr. *Malesia*: Ceram, Japen, New Guinea (all Div.), Rossell I.

Ecol. Terrestrial in rain-forest, from sea level to *c.* 1500 m; often described as locally frequent.

#### Excluded

*Tapeinidium bartlettii* COPELAND, Un. Cal. Publ. Bot. 14 (1929) 376, pl. 60 = *Xyopteris stortii* (V.A.V.R.) KRAMER.

*Tapeinidium moluccanum* (BLUME) C. CHR. Ind. Fil. Suppl. 3 (1934) 176 = *Saccoloma* *sp.* (see under *T. amboynense*).

*Tapeinidium tenue* (BRACKENR.) COPELAND, Bull. Bish. Mus. 59 (1929) 69 = *Saccoloma* *sp.* (see under *T. denhamii*).

### 3. XYOPTERIS

KRAMER, Act. Bot. Neerl. 6 (1957) 599.

In most respects similar to the larger species of *Tapeinidium*. *Lamina* simply pinnate. *Pinnae* of full-grown plants on the acroscopic side of the base sharply auriculate. *Sori* plurinerval, in full-grown plants quite continuous and occupying all vein-ends.

Distr. Monotypic.

Note. This is undoubtedly a close relative of *Tapeinidium*. That genus is, however, so homogeneous in its short sori that the present species is better excluded.

**1. *Xyopteris stortii*** (V.A.V.R.) KRAMER, Act. Bot. Neerl. 6 (1957) 599, with fig.—*Schizoloma stortii* V.A.V.R. Bull. Jard. Bot. Btzig II, 16 (1914) 36; Handb. Suppl. 1 (1917) 214.—Type: AMDJAH (V. GENDEREN STORT's coll.) 711, Mt Djempanga, Kalimantan, Borneo (BO; dupl. in K, L; fragm. in BM).

*Tapeinidium bartlettii* COPELAND, Un. Cal. Publ. Bot. 14 (1929) 376, pl. 60.—Type: BARTLETT 6731a, near waterfall Si Saliang, Asahan, Sumatra (dupl. in GH, L, MICH).

*Rhizome* rather short-creeping, in full-grown plants to 1  $\frac{1}{4}$  cm  $\sigma$ ; scales golden-brown, elongate-triangular, acuminate, to 5 by 1  $\frac{1}{2}$  mm, to *c.* 18-seriate at base. *Petioles* close, to a few mm apart, to 40 cm long, to 1  $\frac{1}{2}$  cm  $\sigma$  at base, more slender upward, stramineous to fawn-coloured, abaxially terete, or in young plants somewhat angular,

adaxially flattened to sulcate. *Lamina* 70 to 150 cm long, but already fertile in young plants and then *c.* 30 cm long, oblong, with up to 18 pinnae to a side; rachis like the petiole, adaxially narrowly sulcate. *Pinnae* ascending, alternate, very narrowly lanceolate, 15–30 cm long, 1  $\frac{1}{2}$ –3 cm wide, the upper ones shortened, 4–10 cm long; texture chartaceous to subcoriaceous, colour olivaceous when dry; base of (especially larger) pinnae stalk-like, to 1 cm long. *Margin* obliquely and distantly serrate in young plants, entire with only a few teeth near the apex in full-grown ones. *Lamina* of pinnae unequal at the base, the basicopic side narrower, the acroscopic side with a large acute auricle to 7 cm long, this wanting in juvenile plants. Costa median, percurrent, pale, prominent on both sides, adaxially sulcate; veins immersed, evident, very oblique, less so

outward, mostly 2 or 3 times forked, free; auricles of pinnae with a costule. *Upper pinnae* in large leaves 4–10 cm long; terminal pinna free, to c. 15 cm long, unequally and deeply trilobate, with long-acuminate lobes, the central shank much longer than the lateral ones. *Sori* plurinerval but interrupted in young, continuous in adult plants, absent only from the extreme base and apex of the pinnae and the apex of the auricle; indusium brown, entire or wavy,  $\frac{1}{4}$ – $\frac{1}{3}$  mm wide, not reaching the margin by about its own width,  $\pm$  reflexed at maturity. Multicellular filiform

paraphyses present among the sporangia. Spores medium brown, monolete, bean-shaped, smooth, c. 50–60 by 30–35  $\mu$ .

Distr. *Malesia*: Sumatra (3 coll.), Borneo (Kalimantan) (type coll.).

Ecol. In ravines by streams, c. 300–500 m; presumably a rheophyte.

Note. An excellent series of specimens from Sumatra (SURBECK 49, L, U), including young as well as full-grown plants, shows that *Tapeinidium bartlettii* COPELAND is the juvenile form of *X. stortii*.

#### 4. LINDSAEA

DRYANDER in J. E. Smith, Mém. Ac. Turin 5 (1793) 401; Trans. Linn. Soc. 3 (1797) 39; HOOKER, Sp. Fil. 1 (1846) 203; J. SMITH, Hist. Fil. (1875) 267; DIELS in E. & P. Nat. Pfl. Fam. I, 4 (1902) 219; v.A.v.R. Handb. (1908) 260; Suppl. (1917) 202; HOLTTUM, Gard. Bull. S. S. 5 (1930) 58; TAGAWA, Act. Phytotax. Geobot. 6 (1937) 24; COPELAND, Gen. Fil. (1947) 52; Philip. J. Sc. 78 (1949) 15; HOLTTUM, Rev. Fl. Mal. 2 (1954) 321; KRAMER, Act. Bot. Neerl. 6 (1957) 97; CHING, Fl. Reip. Pop. Sin. 2 (1959) 257; KRAMER, Blumea 15 (1968) 557.—*Davallia* J. E. SMITH *sensu* HOOKER, Sp. Fil. 1 (1845) 151, *p.p.*—*Schizoloma* GAUD. Ann. Sc. Nat. 3 (1824) 507, *p.p.*; J. SMITH, Hist. Fil. (1875) 270, *p.p.*; DIELS in E. & P. Nat. Pfl. Fam. I, 4 (1902) 218, *p.p.*; v.A.v.R. Handb. (1908) 275; Suppl. (1917) 214; HOLTTUM, Rev. Fl. Mal. 2 (1954) 342; CHING, Fl. Reip. Pop. Sin. 2 (1959) 272.—*Isoloma* J. SMITH, Hook. J. Bot. 3 (1841) 414; Hist. Fil. (1875) 227; COPELAND, Gen. Fil. (1947) 55; Philip. J. Sc. 78 (1949) 24; HOLTTUM, Rev. Fl. Mal. 2 (1954) 336; COPELAND, Fern Fl. Philip. 1 (1958) 100.—*Odontoloma* J. SMITH, Hook. J. Bot. 3 (1841) 415, *nom. subnud.*; in Hooker & Bauer, Gen. Fil. (1842) pl. 114 B; FÉE, Gen. Fil. (1852) 329; J. SMITH, Hist. Fil. (1875) 269.—*Synaphlebium* J. SMITH in Hooker & Bauer, Gen. Fil. (1842) pl. 101; Hist. Fil. (1875) 268.—*Lindsaenium* (or *Lindsaynium*) FÉE, Mém. Soc. Mus. Hist. Nat. Strasb. 4 (1850) 201; Gen. Fil. (1852) 333.

The name is often misspelled '*Lindsaya*'.

Small to medium-sized, terrestrial, epilithic, scandent, or epiphytic ferns with a Lindsaeoid protostele, the xylem with an internal phloem strand, or in some small epiphytes open. Scales variable in shape, mostly entire. *Lamina* rarely simple, mostly once or twice pinnate, sometimes more dissected, to decompose, anadromous; ultimate divisions various, most often dimidiate, sometimes partly or entirely equal-sided, rarely cuneate and dichotomously divaricate. Veins free, connivent, or anastomosing without free included veinlets. *Sori* terminal on the veins, bi- to plurinerval, less often uninerval, mostly very close to the margin. Indusium short, roundish, ovate, or hippocrepiform and then free at the sides, or more elongate, and laterally free or adnate, rarely fugacious. Bicellular filiform paraphyses present in some, probably in all species. Spores trilete or (very rarely in the Old World species) monolete.

Type species: *Lindsaea trapeziformis* DRYANDER (neotropical).

Distr. About 150 *spp.*,  $\frac{2}{3}$  in the Old World, but few in continental Africa; extending north to Japan, south to Tasmania, east to the Marquesas.

Descriptive terms. In accordance with the terminology used earlier in the Lindsaea group (KRAMER, 1957) the term 'pinnule' is always used for an ultimate free division, regardless of the degree of dissection



of the lamina which bears it, except in some species of *sect. Schizoloma*, in which there are transitions from simple entire primary pinnae to pinnate ones. If the division is not entirely free it is called a segment. The length of a sorus is always measured at right angles to the vein(s) bearing it, its width parallel to (in prolongation of) the vein(s).

SUBDIVISION OF THE GENUS

The subgenera of *Lindsaea*, as proposed in the past, proved as a whole unsatisfactory. Too much value was attached to such characters as the shape of the pinnules and their venation and the length of the sori. Some of the subgenera defined on such characters were even raised to generic rank. It seems that these features are useful, together with several others, for distinguishing species, or sections at the most. It can be demonstrated, for instance, that anastomosing veins have independently arisen in four groups of species, here treated as sections *Synaphlebium*, *Schizoloma*, *Lindsaenium*, and *Penna-arborea*, respectively. A feature of much more fundamental importance seems to be the morphology and anatomy of the rhizome. This led to the distinction of two clear-cut groups, treated as subgenera (KRAMER, *Blumea* 15, 1968, 557 *seq.*). Apparently natural, but not necessarily entirely sharply defined groups of species are treated as sections under these two subgenera. The number of characters available at present for defining these groups is relatively small in the *Lindsaea* group, these rather primitive ferns being of simpler structure than most other leptosporangiate ferns. As in some species, notably in *sect. Schizoloma* and *sect. Synaphlebium*, not all specimens show the sectional characters very clearly, the key to the species has not primarily been constructed on the basis of the sections, although in many instances most or all species of a section will be found together.

SYNOPSIS OF MALESIAN SUBGENERA AND SECTIONS

1. Rhizome essentially terrestrial, short- to moderately long-creeping, the stele radially symmetric or nearly so. SUBG. LINDSAEA.
  2. Lamina bi-(tri-)pinnate, with the upper pinnae gradually reduced, a conform terminal pinna wanting; or simply pinnate (rarely simple), with equal-sided pinnules and anastomosing veins (one species with combinations of both possibilities). *Spp.* 1-8 . . . . . 1. *Sect. Schizoloma*
  2. Lamina bipinnate, with a conform terminal pinna; or simply pinnate, with free veins, or, if the veins are anastomosing, with dimidiate pinnules.
    3. Lamina simply pinnate, with  $\pm$  equal-sided pinnules; rachis  $\pm$  sclerotic.
      4. An articulation at the base of each pinnule. *Spp.* 36-41 . . . . . 8. *Sect. Isoloma*
      4. No articulations at the pinnule-bases. *Sp.* 35 . . . . . 7. *Sect. Psammolindsaea*
    3. Lamina bipinnate, or, if simply pinnate, with dimidiate pinnules; rachis various.
      5. Lamina simply pinnate, the rachis strongly sclerotic, abaxially sharply carinate. *Sp.* 34. . . . . 6. *Sect. Tropicodolindsaea*
      5. Lamina bipinnate, or, if simply pinnate, the rachis not simultaneously sclerotic and abaxially carinate.
        6. Veins anastomosing, sometimes only irregularly. *Spp.* 15-30 . . . . . 3. *Sect. Synaphlebium*
        6. Veins free.
          7. Spores monolet; lamina simply pinnate, with abaxially rounded rachis and (except in small forms) interrupted sori. *Sp.* 33 . . . . . 5. *Sect. Osmolindsaea*
          7. Spores trilete; if lamina simply pinnate and rachis abaxially rounded, the sori continuous.
            8. Lamina simply pinnate, basally distinctly reduced and/or with more widely spaced pinnules; petiole and rachis abaxially bi-angular; pinnules not more than twice as long as broad, or, if longer, deeply incised. *Spp.* 42-43 . . . . . 9. *Sect. Stenolindsaea*
            8. Lamina bipinnate, or, if simply pinnate, basally not reduced nor with remote pinnules and the axes abaxially terete.
              9. Sori continuous; pinnules entire. *Spp.* 31-32 . . . . . 4. *Sect. Lindsaea*
              9. Sori interrupted, pinnules  $\pm$  incised. *Spp.* 9-14. . . . . 2. *Sect. Temnolindsaea*
    1. Rhizome epiphytic, long-creeping, the stele strongly dorsiventral. SUBG. ODONTOLOMA.
      10. Rhizome wiry, not over 1 1/4 mm thick, with an open xylem strand, deciduously scaly, more persistently so only near the petiole bases, lustrous when naked. Leaves simply pinnate. Veins free or anastomosing. *Spp.* 60-62 . . . . . 13. *Sect. Penna-arborea*
      10. Rhizome 1-2 mm or more thick (except in a few small species), with a closed xylem strand, more persistently scaly, not lustrous when naked. Leaves simply pinnate, free-veined, or bipinnate, free- or reticulate-veined.
        11. Lamina simply pinnate, the rachis on the adaxial side not grooved to the base (exc. often in *L. capillacea*). *Spp.* 44-51 . . . . . 10. *Sect. Odontoloma*
        11. Lamina bipinnate, in some species occasionally also simply pinnate leaves present, these with the rachis on the adaxial side grooved to the base.
          12. Pinnules entire, with uninterrupted sori. *Sp.* 52. . . . . 11. *Sect. Pseudolancea*
          12. Pinnules incised, with interrupted sori, or with only one short sorus near the apex, otherwise sterile. *Spp.* 53-59 . . . . . 12. *Sect. Lindsaenium*

## KEY TO THE SPECIES

1. Lamina pinnate + deeply pinnatifid, bipinnate, or more compound, without conform terminal pinna, the upper (primary) pinnae gradually reduced (fig. 20, 21) . . . . . **Group A**
1. Lamina simple, simply pinnate, or, if bipinnate or subtripinnate, with a conform terminal pinna sharply set off from the upper lateral pinnae.
2. Ultimate free divisions not, or only a very short basal portion, dimidiate.
3. Veins anastomosing, sometimes irregularly so . . . . . **Group A**
3. Veins quite free.
4. Leaf-apex and pinna-apices or the entire pinnae triangular or rhombic-triangular, acuminate . . . . . **5. *L. javanensis***
4. Leaf- and pinna-apices otherwise.
5. Pinnules articulate with the rachis . . . . . **Group E**
5. Pinnules continuous with the rachis (*sect. Psammolindsaea*) . . . . . **35. *L. walkerae***
2. Ultimate pinnules dimidiate.
6. Rhizome long-creeping, epiphytic or scandent, with remote leaves; stele dorsiventrally symmetric . . . . . **Group G**
6. Rhizome short-creeping, terrestrial, or exceptionally longer and sometimes epiphytic (in case of doubt both choices will lead to the correct species), with radially or nearly radially symmetric stele.
7. Veins free.
8. Sori continuous in fully fertile pinnules.
9. Petiole pale, abaxially terete; or, if upward obtusely bi-angular, the upper pinnules little reduced, the terminal segment (pinnule) large, hastate, and the larger pinnules 2 cm or more long and over twice as long as wide . . . . . **Group D**
9. Petiole pale or dark, abaxially bi-angular; upper pinnules much reduced, the terminal segment small, not hastate; or the larger pinnules smaller and not over 1½ times as long as wide.
10. Larger, basal pinnules asymmetrically suborbicular, only the basal half dimidiate (fig. 15); simply pinnate sterile leaves with sharply dentate pinnules often present . . . . . **3. *L. orbiculata***
10. Pinnules entirely dimidiate, not suborbicular; sterile leaves not usually present, their pinnules not sharply dentate . . . . . **Group C**
8. Sori interrupted in fully fertile pinnules.
11. Simply pinnate; rachis abaxially rounded or narrowed-rounded; spores monolete (*sect. Osmolindsaea*) . . . . . **33. *L. odorata***
11. Simply pinnate; rachis abaxially keeled; spores trilete (*sect. Tropidolindsaea*) . . . . . **34. *L. adiantoides***
11. Simply pinnate, with abaxially bi-angular rachis; or bi-(subtri)-pinnate; spores trilete.
12. Simply pinnate; pinnules up to 2½ times as long as wide; lamina basally mostly at least somewhat reduced . . . . . **Group F**
12. Simply pinnate; at least some pinnules over 2½ times as long as wide; lamina truncate at the base . . . . . **Group C\***
12. Bipinnate . . . . . **Group B\***
7. Veins anastomosing . . . . . **Group C**

**Group A (*sect. Schizoloma*)**

1. Veins free.
2. Pinnae in the basal part with segments only on the acroscopic side, in the apical part on both sides (fig. 19); lamina pinnate + deeply pinnatifid. . . . . **1. *L. hemiacroscopica***
2. Pinnae equal-sided, or basiscopically more compound than acroscopically; simply pinnate with entire pinnules, bipinnate, or more compound.
3. Terminal segment of lateral pinnae narrow, acute, small in comparison to the pinnules next to it (fig. 21); indusium not or scarcely erose, falling short of the margin by less than half its width . . . . . **2. *L. bouillodii***
3. Terminal segment of lateral pinnae broad, rhombic, obtuse, or sometimes acuminate-caudate, large in comparison to the pinnules next to it; or lamina simply pinnate; indusium falling short of the margin by more than half its width (except often in *L. javanensis*).
4. Terminal segment of lateral pinnae (if any) as large as or often much larger than the basal pinnules of that pinna, rhombic to caudate-rhombic; no simply pinnate leaves with sharply dentate pinnules present beside the fertile ones; texture herbaceous to chartaceous; petiole dark, abaxially at least upward obtusely or usually acutely bi-angular . . . . . **5. *L. javanensis***
4. Terminal segment of lateral pinnae about as large as the larger basal pinnules of that pinna, flabellate, suborbiculate (fig. 16); texture subcoriaceous to coriaceous; petiole dark, abaxially mostly rounded; sterile leaves with crenate pinnules often present. . . . . **4. *L. gomphophylla***

\* In case of doubt both ways will lead to the correct species.

4. Terminal segment of lateral pinnae (if any) smaller than the larger basal pinnules of that pinna, rhombic, obtuse; texture herbaceous to chartaceous; petiole pale to dark, abaxially at least upward sharply bi-angular; unipinnate sterile leaves with sharply dentate pinnules often present . . . . . 3. *L. orbiculata*
1. Veins anastomosing, sometimes irregularly so and then some pinnules quite free-veined.
5. Larger secondary pinnules dimidiate, trapezoidal; pinnae without a large lanceolate undivided apical portion . . . . . 6. *L. media*
5. Free secondary pinnules (if present) flabellate, not dimidiate; pinnae entire or with a large lanceolate undivided apical portion.
6. Veins even in larger pinnae (pinnules) irregularly anastomosing; upper (primary) free pinnules relatively wide, c. 1-3 times as long as wide . . . . . 7. *L. heterophylla*
6. Veins regularly anastomosing, except in small secondary pinnules (if present); upper (primary) pinnules mostly relatively narrower . . . . . 8. *L. ensifolia*

Group B (sect. *Temnolindsaea*)

1. Petiole and rachises abaxially keeled . . . . . 14. *L. tenuifolia*
1. Petiole and rachises abaxially bi-angular, rarely only obscurely so.
2. Basal (primary) pinnae strongly reduced (fig. 25) . . . . . 9. *L. kingii*
2. Basal pinnae hardly or not reduced.
3. Pinnules incised beyond  $\frac{3}{4}$  of their width, with capillary segments 0.2-0.4 mm wide, wider at the sorus, the wing connecting them as wide (fig. 28); sori uninerval . . . . . 13. *L. polyctena*
3. Pinnules at the base incised beyond the middle, the segments not capillary, 0.3-0.8(-1) mm wide, connected by a wing of  $\frac{1}{2}$ -1 mm; sori very predominantly uninerval . . . . . 12. *L. tetragona*
3. Pinnules at the base not incised to the middle, the segments 0.8 mm wide or more; sori usually on more than one vein (except in *L. tetragona*).
4. Outer incisions of the pinnules reaching to the middle; lobes longer than broad.
5. Sori uni- or binerval; largest pinnules 10-12 mm long . . . . . 12. *L. tetragona*
5. Sori bi- or trinerval; largest pinnules 7-8 mm long. . . . . 10. *L. multisora*
4. No incisions reaching beyond  $\frac{1}{4}$  of the width of the pinnules; lobes broader than long.
6. Veins 1 mm apart . . . . . 11. *L. natunae*
6. Veins  $\frac{1}{2}$  mm or less apart . . . . . see Group C

Group C (sect. *Synaphlebium*)

1. Veins of larger fertile pinnules irregularly anastomosing, sometimes almost or even quite free (see also 3. *L. orbiculata*).
2. Sori continuous; pinnules narrowed from base to apex, 5-15 mm long, 2-2½ mm wide; veins adaxially impressed, abaxially prominulous; larger pinnules rarely entirely free-veined; sterile pinnules sinuate-dentate; petioles rarely pale, usually brown, abaxially obtusely to acutely bi-angular . . . . . 27. *L. crispa*
2. Sori continuous or interrupted, the incisions of the pinnules not reaching 1 mm deep in fully fertile pinnules; pinnules very little narrowed close to the apex, 10-12 mm long, 3-4 mm wide, often 3½-4 times as long as wide; veins immersed; pinnules often quite free-veined; petiole pale, abaxially flat or convex, bi-angular, the angles evanescing downward; sterile pinnules broadly crenate-sinuate . . . . . 16. *L. napaea*
2. Sori interrupted; pinnules scarcely narrowed to the apex, 10-20 mm long, 4-6 mm wide, their incisions to 1 mm deep; veins immersed; pinnules often without any anastomoses; petiole pale, abaxially angular to the base, at least near the apex sulcate; sterile pinnules bicrenate. . . . . 15. *L. malayensis*
1. Veins of larger fertile pinnules regularly anastomosing, at least in the basal half of the pinnules.
3. Sori of larger, fully fertile pinnules continuous.
4. Upper pinnules little reduced,  $\pm$  half as long as the larger ones; terminal segment comparatively large, lanceolate, free or nearly so (fig. 32b).
5. Pinnules twice as long as wide; petiole usually reddish brown . . . . . 25. *L. integra*
5. Pinnules 2½-3 times as long as wide; petiole stramineous . . . . . 23. *L. cultrata*
4. Upper pinnules strongly reduced, some denticuliform ones connected with the narrow pinna-apex.
6. Pinnules not over twice as long as wide.
7. Larger pinules 5-7 mm long, 3-4 mm wide; pinnae strongly ascending; outer veins, in small pinnules sometimes all or nearly all veins free; never 2 series of areoles . . . . . 20. *L. ramosii*
7. Larger pinnules 9-15 mm long, 4-7 mm wide; pinnae laxly ascending; veins regularly anastomosing; not rarely two series of areoles between lower and upper margin . . . . . 26. *L. azurea*
6. Pinnules 2½ to over 3 times as long as wide.
8. Larger pinnules 16-20 mm long . . . . . 24. *L. papuana*
8. Larger pinnules to 12 mm long . . . . . 16. *L. napaea*
3. Sori of larger pinnules interrupted by incisions of the margin.

9. Terminal pinnule free, cuneate or cuneate-flabellate (fig. 34); rhizome not very short-creeping.
10. Sori bi- to trinerval; pinnules translucent; terminal pinnule narrowly cuneate or with 2 narrowly cuneate divisions . . . . . 30. *L. modesta*
10. Sori quadri- to plurinerval; pinnules opaque; terminal pinnule flabellate . . . . . 29. *L. obscura*
9. Terminal segment narrow, connected with some denticuliform upper pinnules, or, if  $\pm$  free, triangular, acute.
11. Pinnules 2–3½ cm long, 3–3½ times as long as wide; simply pinnate . . . . . 17. *L. subalpina*
11. Pinnules under 2 cm long, not over 3 times as long as wide; lamina usually bipinnate.
12. Pinnules opaque, hardly narrowed to the obliquely truncate apex; outer margin distinct, with an incision; pinnae rather suddenly narrowed below the  $\pm$  caudate, pinnatifid apex (fig. 29); pinnule-bearing rachises abaxially brown, sulcate and pale-margined. 22. *L. paralelogramma*
12. Pinnules with subacute to rounded apex, and/or distinctly narrowed to apex; or, if truncate, the outer margin not incised; pinnules often translucent; pinnae more gradually narrowed; pinnule-bearing rachises various.
13. Pinnules twice as long as broad, to 5 mm long. . . . . 28. *L. hewittii*
13. Pinnules more elongate, or, if not, at least 7 mm long.
14. Pinnae (if any) strongly ascending; pinnules 7–10 by 3½–5 mm, 1½–2½ times as long as wide; indusium not reaching the margin by more than half its width . . . . . 19. *L. longifolia*
14. Pinnae (if any) not strongly ascending; pinnules larger, or, if 10 mm or less long, over 2½ times as long as wide, or the indusium closer to the margin.
15. At least the inner incisions reaching to ⅓ or ½ of the width of the pinnules; pinnules translucent; all lobes and receptacles distinctly convex; indusium reaching the margin or very nearly so. . . . . 21. *L. lobata*
15. Pinnules more shallowly incised, or, if the inner incisions reach ⅓, the pinnules not translucent, or the inner or all lobes and receptacles straight.
16. Pinnules usually with the upper margin convex, the lower concave, i.e., slightly falcately decurved; a distinct outer margin present, joining the upper at an angle of less than 90°, its sorus mostly continuous with the outermost one of the upper margin; at least the inner incisions reaching considerably beyond the receptacle . . . . . 23. *L. cultrata*
16. Pinnules usually as above; a distinct outer margin wanting, rounded into the upper; most or all incisions reaching considerably beyond the receptacle . . . . . 18. *L. obtusa*
16. Pinnules usually with both margins straight or faintly convex; no distinct outer margin developed, rounded into the upper; incisions reaching to the level of the receptacle or shallower . . . . . 16. *L. napaea*

#### Group D (sect. *Lindsaea*)

1. Pinnules to 11 mm long, to 5 mm wide . . . . . 31. *L. borneensis*
1. Pinnules to 20(–35) mm long, to 6(–13) mm wide . . . . . 32. *L. doryphora*

#### Group E (sect. *Isoloma*)

1. Pinnules 5 times or more as long as broad, 3–4 mm wide (apart from basal auricles), with contiguous bases . . . . . 41. *L. divergens*
1. Pinnules relatively much shorter, or, if up to 5 times as long as wide, 8 mm wide (apart from basal auricles) and at least in the basal half of the lamina not contiguous.
2. Pinnules suborbicular, not more than 1 mm longer than broad, coriaceous, not auricled; rachis black, lustrous . . . . . 40. *L. jamesonioides*
2. Pinnules ovate to lanceolate, the difference between length and width greater; at least some pinnules distinctly auricled; rachis brown to black, lustrous or not.
3. Rachis blackish, lustrous, abaxially keeled to the base; upper pinnules little or not reduced, terminal division free . . . . . 37. *L. ovata*
3. Rachis not blackish and lustrous, or, if so, not keeled to the base; upper pinnules reduced, some confluent with the terminal segment.
4. Rachis dull, medium to dark reddish brown, rarely darker or lustrous; pinnules obtuse or rarely subacute, the larger ones 7–18 mm long, up to 2½ times as long as wide . . . . . 36. *L. gueriniana*
4. Rachis lustrous, reddish to dark brown; pinnules obtuse, the larger ones 5–8 mm long, less than 1½ times as long as wide . . . . . 39. *L. philippinensis*
4. Rachis dull, dark brown; pinnules acute or rarely subacute, the larger ones 18–30 mm long, to 4 times as long as wide . . . . . 38. *L. pellaeiformis*

#### Group F (sect. *Stenolindsaea*)

1. Pinnules entire, or, if incised, the inner incisions of larger pinnules not going beyond the middle . . . . . 42. *L. lucida*
1. Pinnules incised far beyond the middle . . . . . 43. *L. bakeri*

Group G (subg. *Odontoloma*)

1. Rhizome wiry, not over  $1\frac{1}{4}$  mm  $\sigma$ , deciduously scaly, eventually naked, dark brown to blackish, polished, with open xylem strand; lamina simply pinnate but the pinnules sometimes incised (*sect. Penna-arborea*).
2. Veins anastomosing; larger pinnules  $1\frac{1}{2}$ –3 cm long; few or no upper pinnules strongly reduced.
3. Terminal segment narrow, lanceolate or caudate (fig. 38) . . . . . 61. *L. wernerii*
3. Terminal pinnule broad, obtuse, cuneate or flabellate. . . . . Group C
2. Veins free, or, if anastomosing, the largest pinnules less than  $1\frac{1}{2}$  cm long; upper pinnules gradually and strongly reduced.
4. Pinnules deeply pinnatifid, the segments connected by wings  $\frac{1}{4}$ – $\frac{1}{2}$  mm wide (fig. 23) . . . . . 62. *L. roemeriana*
4. Pinnules shallowly incised, or, if more deeply incised, the lobes much more broadly connected. . . . . 60. *L. pulchella*
1. Rhizome not wiry,  $1\frac{1}{2}$ –2 mm  $\sigma$ , or, if thinner, not polished when naked, with closed, strongly dorsiventral xylem strand.
5. Lamina always simply pinnate (species where this character fluctuates can be keyed out both ways).
6. Lamina truncate at the base, with a well-developed petiole and few or no reduced basal pinnules; pinnules incised considerably beyond the receptacle.
7. Veins anastomosing . . . . . Group C
7. Veins free.
8. Pinnules very regularly incised (fig. 50); sori distinctly intramarginal, mostly uni-, some binerval. . . . . 47. *L. apoensis*
8. Pinnules irregularly incised; sori uni- to quadrinerval, very close to the margin, the sporangia often spreading beyond it at full maturity . . . . . 46. *L. repens*
6. Lamina gradually and strongly narrowed at the base, the petiole often very short or virtually absent; pinnules subentire to variously incised.
9. Pinnules incised far beyond the middle; sori uni- or binerval.
10. Pinnule-lobes truncate, their outer margin erose to cernicate (fig. 46, 47).
11. Rhizome  $\frac{1}{2}$  mm  $\sigma$ ; ultimate pinnule-lobes 0.4–0.8 mm wide near the apex, there laterally with two horn-like projections 0.3–0.4 mm long (fig. 46); sori uninerval. . . . . 51. *L. capillacea*
11. Rhizome  $\frac{3}{4}$ –2 mm  $\sigma$ ; ultimate pinnule-lobes  $\frac{1}{2}$ –2 mm wide near the apex, there laterally without, or with rudimentary horn-like projections (fig. 47); sori not rarely binerval . . . . . 50. *L. fissa*
10. Pinnule-lobes rounded or narrowed to subacute, not truncate.
12. Pinnule-lobes 0.3–1 mm wide, nearly all of them once or twice bifid, joined by wings of less than  $\frac{1}{2}$  mm width (fig. 48). . . . . 49. *L. carvifolia*\*
12. Pinnule-lobes 1 mm or more wide, joined by wings of 1 mm or more (fig. 49) . . . . . 44. *L. glandulifera*
9. Pinnules subentire to incised to the middle; sori uni- to plurinerval.
13. Sori continuous (shortly interrupted in very shallowly incised, incompletely fertile pinnules); rhizome scales chocolate brown . . . . . 45. *L. oblanceolata*
13. Sori interrupted (beware of old, abundantly fertile pinnules where the sori may be confluent); scales golden brown (darker in some varieties of *L. repens* with more deeply incised pinnules).
14. At least some of the fertile lobes denticulate or erose; sterile lobes acute, tooth-like (fig. 42). . . . . 48. *L. merrillii*
14. Fertile lobes not denticulate, erose, or tooth-like, but truncate, rounded, or narrowed-rounded.
15. Larger pinnules 10–12 mm long; pinnules incised to  $\frac{1}{3}$  or  $\frac{1}{2}$ , the lobes evenly narrowed from base to apex (fig. 49) . . . . . 44. *L. glandulifera*
15. Larger pinnules 15 mm or more long, with truncate or apically rounded lobes, or, if shorter, much less deeply incised, or the lobes  $\pm$  parallel-sided. . . . . 46. *L. repens*\*\*
5. Lamina of all, most, or at least some leaves bipinnate.
16. Sori continuous . . . . . 52. *L. parasitica*
16. Sori interrupted.
17. Secondary rachises abaxially rounded . . . . . 54. *L. monocarpa*
17. Secondary rachises abaxially carinate . . . . . 55. *L. sarawakensis*
17. Secondary rachises abaxially bi-angular (and/or sulcate) at least in the upper half.
18. Pinnules coriaceous; veins sometimes anastomosing . . . . . 53. *L. rigida*
18. Pinnules herbaceous or chartaceous.
19. Pinnules shallowly incised, at the most to the receptacle or slightly beyond, never to the middle.

\* Simply pinnate forms of *L. rosenstockii* and *L. versteegii* will also run to this heading. The former has only the basal pinnule-lobes bifid, the latter has more divergent lobes (see fig. 39 and 40).

\*\* Simply pinnate forms of *L. microstegia* will also run here; their basal pinnules are inserted on the edge of the adaxial face of the rachis, not below it, as in *L. repens*.

20. Adaxial groove of the primary rachis broad, occupying half of its width or more; most pinnules fertile only near the apex; veins sometimes anastomosing; indusium not reaching the margin by less than its width; bipinnate . . . . . 53. *L. rigida*\*
20. Adaxial groove of the primary rachis narrow, occupying much less than half its width; most pinnules entirely fertile; veins free; indusium not reaching the margin by less than its width; bipinnate . . . . . 56. *L. regularis*
20. Adaxial groove of the primary rachis narrow, occupying much less than half its width; most pinnules entirely fertile; veins free; indusium not reaching the margin by  $1\frac{1}{2}$ –3 times its width; not rarely simply pinnate leaves present alongside the bipinnate ones 57. *L. microstegia*
19. Pinnules incised considerably beyond the middle.
21. Segments capillary, c.  $\frac{1}{3}$ – $\frac{1}{4}$  mm wide, all forked. . . . . 59. *L. versteegii*
21. Segments not capillary  $\frac{2}{3}$ –2 mm wide, the outer ones often not forked 58. *L. rosenstockii*

### Subgenus *Lindsaea*

#### 1. Section *Schizoloma*

(GAUD.) KRAMER, Act. Bot. Neerl. 15 (1967) 571.—*Schizoloma* GAUD. Ann. Sc. Nat. 3 (1824) 507.

Type species: *Schizoloma billardieri* GAUD. (= *Lindsaea ensifolia* SWARTZ).

Distr. Pantropic, extending far into the temperate zone in Japan, Australia, and New Zealand. Many species concentrated in Madagascar.

Taxon. The short-creeping rhizome and the lamina lacking a conform terminal pinna characterize nearly all species. *L. orbiculata* (LAMK) METT. ex KUHN is sometimes only simply pinnate, and *L. ensifolia* SWARTZ ssp. *ensifolia* is simply pinnate with a conform non-dimidiolate terminal pinna, but otherwise the section is quite clear-cut. It seems to be the most primitive in the genus, with the possible exception of the New Caledonian sect. *Davalliastrum*. Several other subdivisions of the genus comprise one or a few species that show definite affinity with sect. *Schizoloma*; among the most interesting are some Madagascan species with the rhizome of subg. *Odontoloma* but a *Schizoloma*-like leaf architecture.

**1. *Lindsaea hemiacroscopica*** KRAMER, Blumea 15 (1968) 563.—Type: HALLIER 3244, Mt Amai Ambit, Borneo, Kalimantan (BO).—Fig. 19.

*Rhizome* short-creeping, c. 0.6 mm  $\phi$ ; scales reddish brown, c.  $\frac{1}{3}$  cm long, narrowly lanceolate, biseriolate at base, the apical uniseriate part consisting of 1–3 cells. Leaves close; *petioles* 2–4 cm long, somewhat shorter than the lamina, adaxially pale, channelled, abaxially dark brown, sharply bi-angular with narrowly paler edges and flat faces, subterete at base. *Lamina* herbaceous, olivaceous when dry, ovate with truncate base, to 5–6 cm long, 3–4 $\frac{1}{2}$  cm wide, pinnate + deeply pinnatifid, without conform terminal pinna. *Major pinnae* c. 10 to a side, spreading or slightly ascending, less than their width apart, the larger ones 20 by 7 mm, acuminate, inequilateral, deeply pinnatifid. Segments cuneate to ligular, 2 or in larger pinnae 3 on the acroscopic side, 3–4 by 2 mm, with only a very narrow wing on the opposite, basiscopic side; upper segments of acroscopic and all (or all but one) of basiscopic side narrowly cuneate, all narrowed at base and connected by wings of leaf-tissue; uppermost pinnae and segments reduced, confluent. Apex of segments rounded-truncate, entire or sinuate; sterile segments often subacute. Largest segments often bilobed. Costae evident, stramineous; veins immersed, evident, single or in larger lobes paired, one sometimes forked. *Sori* uni-

to trinerval; indusium greyish,  $\frac{1}{2}$ –1 $\frac{1}{2}$  mm long, 0.4 mm wide, suborbicular to oblong, free at the narrowed sides, subentire, not reaching the margin by a little less than its width, not reflexed at maturity. Spores medium brown, trilete, smooth, c. 22  $\mu$ .

Distr. Only known from type collection. No ecological data.

**2. *Lindsaea bouillodii*** CHRIST, Not. Syst. 1 (1909) 59.—Type: BOUILLOD 48, Cam-chay Mts, Cambodia (P).

*L. orbiculata* (LAMK) METT. ex KUHN var. *odontosorioides* COPELAND, Philip. J. Sc. 6 (1911) Bot. 138.—Type: BROOKS 19, Tringos, Sarawak (MICH).

*L. orbiculata* (LAMK) METT. ex KUHN var. *sumatrana* ROSENSTOCK in Fedde, Rep. 13 (1914) 214.—Type: WINKLER 55 (ROS-exs. 117), Batak Lands, Sumatra (S-PA; dupl. in BM, L, P).

*L. cambodgensis* auct. non CHRIST; KRAMER, Blumea 15 (1968) 563.

*L. tenera* auct. non DRYAND. (or *Schizoloma tenerum*) of other authors, e.g., HOLTUM, Gard. Bull. S. S. 5 (1930) 64; Rev. Fl. Mal. 2 (1954) 348, f. 201.—Fig. 21.

*Rhizome* moderately to very short-creeping, 1 $\frac{1}{2}$ –2 mm  $\phi$ ; scales ferruginous, very narrowly triangular, to 2 $\frac{1}{2}$  mm long, to 5-seriate at base, with long uniseriate apex. Leaves close to cluster-

\* Epiphytic specimens with unusually long rhizomes of species of sect. *Synaphlebiium* (Group C) will run to this heading; they have regularly anastomosing veins.

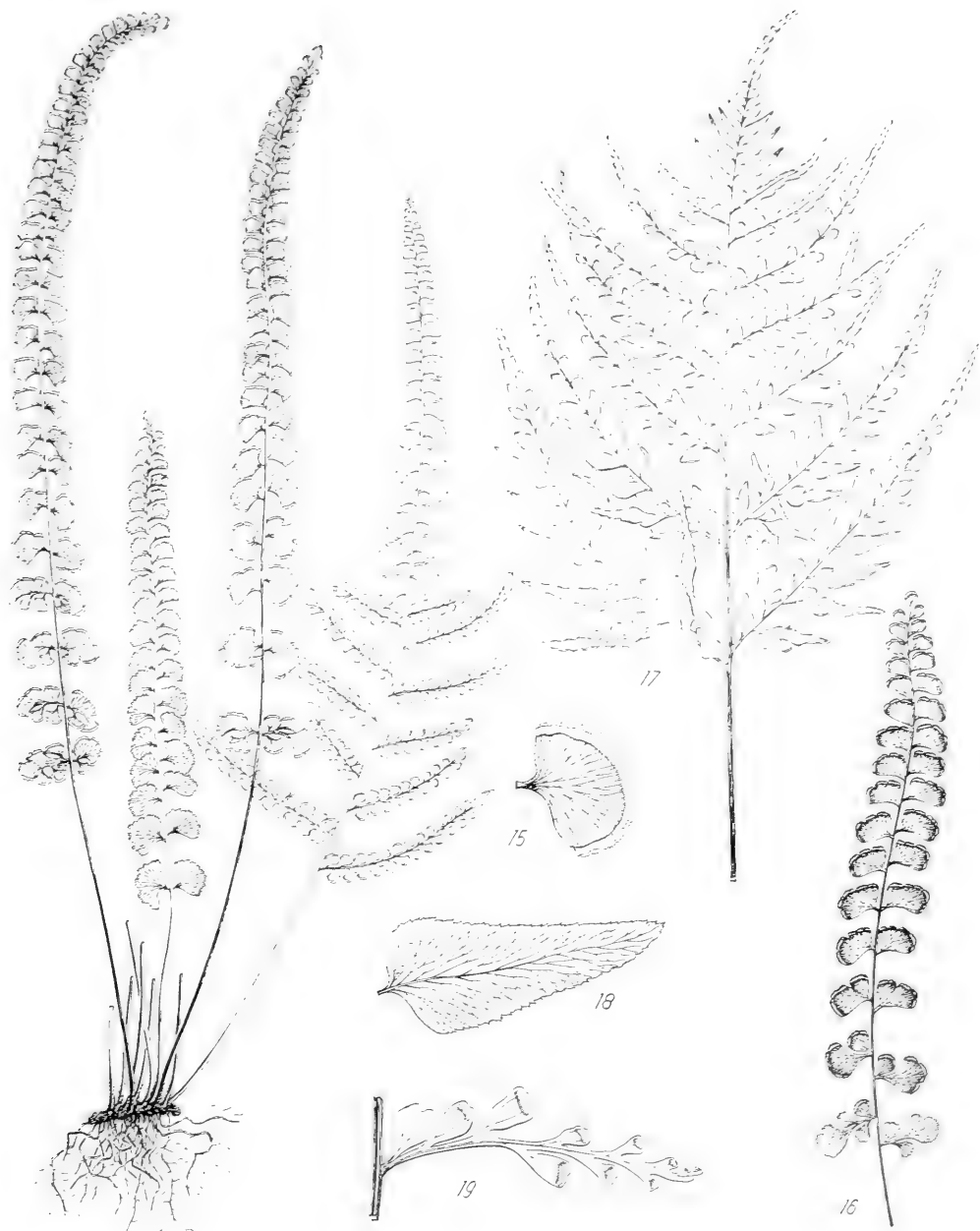


Fig. 15. *Lindsaea orbiculata* (LAMK) METT. ex KUHN var. *orbiculata*. Plant,  $\times \frac{1}{3}$ , pinnule,  $\times 1\frac{1}{4}$  (TANAKA & SHIMADA 13522).—Fig. 16. *L. gomphophylla* BAKER. Lamina,  $\times \frac{1}{3}$  (HOSE? s.n., SAR).—Fig. 17–18. *L. heterophylla* DRYAND.; fig. 17. Lamina,  $\times \frac{1}{3}$  (BAKHUIZEN VAN DEN BRINK 7153); fig. 18. Sterile pinnule, nat. size (PETERSEN s.n., L).—Fig. 19. *L. hemiacroscopica* KRAMER. Basal pinna,  $\times 2$  (HALLIER 3244).

ed; *petioles* 8–40 cm long, to 1½ times as long as the lamina, sharply quadrangular, dark reddish brown, atropurpureous, or blackish, ± pale-margined. *Lamina* ovate or triangular, 12–30 cm long, bipinnate to (at the base) tripinnate + pinnatifid. Primary rachis dark, pale-margined, ± sulcate. *Major primary pinnae* 3–8 to a side, spreading or (mostly not strongly) ascending, subsessile, narrowly oblong, the largest 8–11 cm long, 1¾–2½ cm wide, the lower ones up to their width apart, the upper ones closer; *upper pinnae* gradually reduced, rather abruptly passing into what is almost a conform terminal pinna. Secondary rachises abruptly pale, often ± green-margined. *Lower primary pinnae* not rarely at the base with some pinnate secondary pinnae to c. 2 cm long, rarely the greater part of the lamina with pinnate secondary pinnae with green-margined rachises. *Pinnules* c. 7–12 to a side, herbaceous, dark green when dry, spreading or slightly ascending, not contiguous, subsessile, dimidiate-ovate or less often subtrapeziform, the larger ones 10–13 mm long, 5–7 mm wide, 1½–2 times as long as wide (the basal pinnules of the terminal pinna up to 15 by 10 mm), the upper (and, if present, the outer) margin incised, mostly the upper margin with 1 or 2, the outer with 1 incision, sometimes the lobes shallowly incised again; incisions ½–1½ mm deep, rarely more, the sinus acute; pinnules rarely pinnatifid, with cuneate lobes. *Fertile lobes* somewhat convex, usually slightly erose; sterile pinnules (not rare) with more and narrower, longer, subacute or acute lobes. *Upper pinnules* reduced, a few confluent with the narrow, acuminate or subcaudiform terminal segment; transitions between pinnate and non-pinnate pinnae in the leaf-apex few. Veins immersed, mostly little evident, free, ½–⅔ mm apart, once or twice forked. *Sori* interrupted by the incisions of the margin, convex but scarcely extending onto the sides of the lobes, often 2–4 mm long and 2- to 4-nerval, rarely uninerval; indusium greyish or brownish, subentire or mostly slightly erose, 0.3–0.4 mm wide, almost or quite reaching the margin, not reflexed at maturity. Spores pale brown, trilete, smooth, c. 22 µ.

Distr. Thailand and Tonkin to *Malesia*: Malay Peninsula, Sumatra, West Java, Borneo, Banka, and Natuna Is.

Ecol. Terrestrial in (usually moist) forests, 300–1400 m.

Note. The tripinnate form has been described as *L. orbiculata* var. *odontosorioides*, but it does not seem to merit taxonomic recognition.

3. *Lindsaea orbiculata* (LAMK) METT. ex KUHN in Miq. Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 279; HOLTUM, Gard. Bull. S. S. 5 (1930) 64; TAGAWA, Act. Phytotax. Geobot. 6 (1937) 33, f. 3 D-G; COPELAND, Fern Fl. Philip. 1 (1958) 112, p.p.—*Adiantum orbiculatum* LAMK, Encycl. 1 (1783) 41.—*Schizoloma orbiculatum* (LAMK) KUHN, Chaetopt. (1882) 346; HOLTUM, Rev. Fl. Mal. 2 (1954) 344, f. 199.—*Schizolegnia orbiculata* (LAMK) ALSTON, Bol. Soc. Brot. II,

30 (1956) 24.—Type: SONNERAT *s.n.*, near Malacca (P).

*L. flabellulata* DRYAND. Trans. Linn. Soc. 3 (1797) 41, pl. 8 f. 2.—Lectotype: NELSON *s.n.*, Macao (BM).

*L. polymorpha* WALL. ex HOOKER & GREVILLE, Ic. Fil. (1828) pl. 75.—*L. flabellulata* DRYAND. var. *polymorpha* (HOOK. & GREV.) HOOKER, Sp. Fil. 1 (1846) 211.—*L. orbiculata* (LAMK) METT. ex KUHN var. *polymorpha* (HOOK. & GREV.) v.A.v.R. Handb. (1908) 270.—Type: a specimen without data from Herb. HOOKER (K).

*L. montana* COPELAND in Perkins, Fragm. Fl. Philip. (1904) 182, non FÉE (1866).—*L. copelandi* C. CHR. Ind. Fil. (1906) 392.—Type: COPELAND 230, Mt Mariveles, Luzon (MICH; dupl. in B). *L. bonii* CHRIST, Not. Syst. 1 (1909) 187.—Type: BON 8, S. Tonkin (P).

*L. longipes* C. CHR. & TARDIEU-BLOT, Not. Syst. 5 (1936) 263; Fl. Gén. I.-C. 7 (1939) 125, f. 15 3–4.—Type: POILANE 8208, Nhatrang, Annam (P).

*Rhizome* short-creeping, 1–1½ mm ø; scales reddish brown, very narrowly triangular, to c. 2 mm long, to 4-seriate at base, a considerable apical portion uniseriate. Leaves close; *petioles* stramineous with dark base or dark to blackish brown throughout, abaxially at least in the upper part sharply bi-angular and if dark pale-margined. *Lamina* simply pinnate or bipinnate, herbaceous or chartaceous; pinnules dimidiate, very variable in shape, erose, free-veined. Upper pinnae of bipinnate leaves gradually to rather abruptly shortened, ± gradually passing into the non-conform terminal pinna. Terminal pinnules (segments) ± rhombic. *Sori* continuous or interrupted; indusium minutely to strongly and irregularly erose, ½ mm wide, usually falling short of the margin by half its width, rarely more strongly intramarginal or almost reaching the margin. Spores yellow to light brown, trilete, almost smooth, c. 25–30 µ.

#### KEY TO THE VARIETIES

1. Plants usually (always?) with simply pinnate sterile leaves beside the fertile ones; fertile leaves simply pinnate; or, if bipinnate, at least some pinnules at the base of the terminal pinna, above the uppermost pinnate pinnae, suborbicular; the lamina not gradually passing from the bipinnate condition at base to the simply pinnate apex but with a rather abrupt transition . . . . . 1. var. *orbiculata*
1. Sterile simply pinnate leaves mostly wanting; no pinnules suborbicular; larger laminas upward gradually of simpler structure, with a gradual transition from the bipinnate base to the simply pinnate apex . . . . . 2. var. *commixta*

#### 1. var. *orbiculata*.—Fig. 15.

Sterile, simply pinnate leaves mostly, perhaps in nature always, present, together with fertile ones. *Petioles* of sterile leaves slender, stramineous to reddish brown or rarely darker, 2–8 cm long,



mostly about half as long as the lamina; *lamina* linear, c. 5–10 cm long, with 6–12 pinnules to a side (larger ones mostly fertile in the upper part), slightly narrowed from base to apex, there suddenly narrowed. Rachis pale, abaxially bi-angular or sulcate. *Pinnules* mostly olivaceous or dark green when dry, chartaceous, asymmetrically ovate or  $\frac{1}{4}$ -elliptic, often  $\frac{2}{3}$ –1 by  $\frac{1}{2}$  cm, often subcontiguous, spreading or the basal ones decurved, the outer and upper margin sharply dentate, the teeth up to 1 mm long; *terminal pinnule* (segment) free or nearly so, often 1–1½ cm long and  $\frac{1}{2}$ –¾ cm wide, obtuse, less often acute, cuneate-flabellate, toothed, the pinnules just below it mostly not strongly reduced. *Fertile leaves* more numerous, simply pinnate or bipinnate, or very often subbipinnate; intermediates between sterile and fertile leaves not rare. *Petioles* of fertile leaves stouter than those of sterile ones, c. 10–30 cm long, as long as the lamina or in very large leaves sometimes much shorter. *Lamina* linear if once pinnate or subbipinnate, otherwise very variable in shape, depending on the number and size of the pinnae, c. 12–50 cm long. *Pinnules* herbaceous or more often chartaceous, olivaceous or dark green when dry, very variable in number, shape, and size, the lower ones often remote, the upper ones gradually closer, subcontiguous; *rachis* basally sometimes dark, otherwise stramineous, abaxially bi-angular, upward sulcate; secondary rachises, if any, similar. *Fertile pinnules* like the sterile ones or at least the lower ones of simply pinnate leaves, simply pinnate leaf-apices, or larger pinnate pinnae, very asymmetrically flabellate-suborbicular, with broadly rounded upper/outer and  $\pm$  concave, descending lower margin, then often 1–1½ cm long and broad; in subbipinnate laminae some of the lower (but not necessarily the lowermost) pinnae pinnatifid or pinnate, with some cuneate-flabellate or  $\frac{1}{4}$ -elliptic pinnules on both sides and a large, rhombic, very obtuse, often very asymmetric terminal pinnule. *Fully bipinnate leaves* with up to c. 8 well-developed pinnae to a side, these spreading almost at right angles, with up to c. 10 pinnules to a side, the terminal pinnule smaller than in subbipinnate leaves but not much smaller than the lateral pinnules of the same pinna, obtuse. Transitions between pinnate pinnae and lobed pinnules nearly always present at the base of the relatively very long simply pinnate terminal portion of bipinnate leaves, occasionally also between and even below fully pinnate pinnae. Edge of pinnules erose-crispate, rarely dentate. Veins immersed, evident, close, 1–3 times forked, flabellate, a costa not or scarcely developed. *Sori* continuous except as interrupted by incisions of transitional pinnules.

Distr. SE. China, S. Japan, to *Malesia*: Malay Peninsula, Singapore, Sumatra, Banka, Java, Bawean, Sarawak, Sulu Archipelago, Philippines (Luzon); incorrectly reported from Madagascar.

Ecol. In thickets and open forests, on banks and rock faces, often in locally dry situations

in ravines or by rivers or near the coast, to 500 (rarely to 1000) m.

2. *var. commixta* (TAGAWA) KRAMER, *comb. nov.*—*L. commixta* TAGAWA, Act. Phytotax. Geobot. 6 (1937) 37, f. 3 H-J.—*L. tenera* DRYAND. *var. commixta* (TAGAWA) IWATSUKI, Act. Phytotax. Geobot. 19 (1961) 6.—Type: TASIRO *s.n.*, I. Tane-ga-shima, Osumi Prov., Kyushu (KYO, *n.v.*).

? *L. montana* COPELAND.—*L. copelandi* C. CHR.

Differing from *var. orbiculata* in the following characters: Sterile simply pinnate leaves mostly wanting. *Fertile leaves* never simply pinnate; suborbicular pinnules none, even at the base of the simply pinnate leaf-apex, *i.e.*, all pinnules distinctly dimidiate; terminal segments larger and/or more acute. Larger laminae fully bipinnate, more evenly narrowed from base to apex, the terminal pinna hardly set off from the rest of the lamina, the simply pinnate apical portion relatively shorter; *sterile pinnules* more deeply incised; lowest non-subpinnate pinnules of terminal part of lamina shallowly incised, with interrupted sori. Rhizome scales and spores as in *var. orbiculata*.

Distr. SE. China, India, Ceylon, Indo-China, S. Japan, Thailand, to *Malesia*: Malay Peninsula, Sumatra, Philippines (Luzon), Celebes, Sumba, Sarawak.

Ecol. As *var. orbiculata*.

Notes. *L. orbiculata* is one of the most variable species of the genus, resulting in a comparatively extensive synonymy. The two varieties distinguished here are not entirely sharply distinct, partly because depauperate plants from rock fissures *etc.* often cannot be assigned with certainty to one of them, *e.g.* the type of *L. montana* COPELAND, partly because the differences between them are of a gradual rather than fundamental order. Nevertheless the majority of the specimens can be assigned to one of them. *Var. commixta* is more common to the North of *Malesia*, particularly in Japan, where it is fairly sharply distinct from *var. orbiculata* but is not entirely sharply distinguishable from *L. chienii* CHING which I prefer to treat as a species but which may also prove to be only a variety of *L. orbiculata*. Many more field and also cytotoxic observations are needed before the status of the species of this group can be ascertained.

4. *Lindsaea gomphophylla* BAKER, Ann. Bot. 5 (1891) 204.—Type: H. Low *s.n.*, Borneo, prob. Sarawak (K).—Fig. 16.

In most respects like a subbipinnate form of *L. orbiculata*, characterized by the following combination of characters:

*Rhizome scales* castaneous, very narrowly triangular, to 3 mm long, to 6-seriate at base, a considerable apical part uni- and biseriate. *Lamina* subcoriaceous to coriaceous; at least some leaves of each plant subbipinnate, with a few paucijugate pinnae at base, rarely the basal pinnae more fully pinnate; terminal pinnules of lateral pinnae large, flabellate-suborbicular.

*Petiole* and *rachis* dark, abaxially terete or the rachis obtusely bi-angular; secondary rachises abruptly pale. *Sterile margin* less acutely dentate. Spores c. 30  $\mu$ .

Distr. *Malesia*: Borneo (Sarawak, Brunei), Sumatra (5 or 6 coll. in all).

Ecol. One record 300–400 m.

Note. This may be another variety of *L. orbiculata*.

5. *Lindsaea javanensis* BLUME, En. Pl. Jav. (1828) 219. — *Schizoloma javanense* (BLUME) HOLTUM, Rev. Fl. Mal. 2 (1954) 349, f. 202. — *Schizolegnia javanensis* (BLUME) ALSTON, Bol. Soc. Brot. II, 30 (1956) 24. — Type: BLUME s.n., Java (L).

*L. flabellulata* DRYAND. var. *gigantea* HOOKER, Sp. Fil. 1 (1846) 211, pl. 63 c. — *L. orbiculata* (LAMK) METT. ex KUHN var. *gigantea* (HOOKER) METT. ex KUHN in Miq. Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 279. — *L. tenera* DRYAND. var. *gigantea* (HOOKER) HOLTUM, Gard. Bull. S. S. 5 (1930) 65. — *L. gigantea* (HOOKER) C. CHR. Bot. Jahrb. 66 (1933) 53. — Lectotype: GRIFFITH s.n., Khasya and Assam (K).

*Rhizome* short-creeping, 1–2 mm  $\sigma$ ; scales medium brown, lanceolate, long-acuminate, to 1½ mm long, to 4-seriate at base, with a long uniseriate apex. Leaves clustered; *petioles* 10–30 cm long, especially in large leaves much longer than the lamina, dark reddish brown to atropurpureous,  $\pm$  lustrous, abaxially terete at base, upward gradually obtusely, at apex mostly acutely bi-angular, the angles and especially the borders of the adaxial groove often pale. *Lamina* herbaceous to chartaceous, dark green or olivaceous when dry, very variable, triangular or oblong or in small leaves sometimes transversely triangular, 7–20 cm long, 6–15 cm wide, 1¼ to (in large leaves) 1¾ times as long as wide, simply pinnate to amply bipinnate, in the first case with up to as little as 2 pairs of lateral pinnules and a distinct but not conform terminal one, in the second case with up to 5 (pinnate) pinnae to a side and several simple ones above, which are gradually reduced to and confluent (or not) with the terminal pinnule (segment). *Primary rachis* dark, adaxially with a narrow, pale-edged groove, abaxially flattened, pale-angled. *Primary pinnae* their width apart to contiguous, spreading or in plurijugate bipinnate leaves ascending. *Pinnules* of simply pinnate or subbipinnate leaves rhombic, very often with long-acuminate to caudate apex, with very unequal base, basiscopically much more cut away, to c. 8 by 2 cm; apex of lamina similar but  $\pm$  symmetric at base; apices of fully pinnate pinnae similar but smaller, progressively smaller and less pointed as there are more secondary pinnules; larger transitional pinnules between pinnate pinnae and the lamina apex often rhombic-caudate, smaller ones subtrapeziform or subflabellate, very obtuse; pinnules of fully pinnate pinnae up to 8 to a side, mostly not contiguous, subtrapeziform, rounded-rhombic or subflabellate. *Secondary rachises* abaxially flattened or slightly sulcate, abruptly pale at their insertion on the

dark primary rachis, usually distinctly green-margined. Fertile *pinnule-margin* subentire or minutely erose, in larger leaf segments here and there incised by shallow crenations; sterile margin, especially near the segment bases, sharply serrate or dentate, with deeper incisions. Lobes of pointed pinnules often slightly concave. Veins immersed but  $\pm$  evident, free, mostly twice forked, c. 1 mm apart; larger pointed pinnules and terminal divisions with a percurrent costa. *Sori* continuous in small pinnules, progressively more interrupted in larger ones, bi- to plurinerval. Indusium pale, subentire to erose, 0.3–0.4 mm wide, almost reaching the margin to falling short of it by more than its width, little reflexed at maturity. Spores light brown, trilete, smooth, c. 25  $\mu$ .

Distr. Assam, SE. China, and S. Japan to *Malesia*: Malay Peninsula, Sumatra, West Java, Borneo, Celebes (?), Philippines (Sibuyan, Mindoro). Apparently nowhere common. Incorrectly reported from Madagascar.

Ecol. Terrestrial in forests, 80–1400 m, mostly above 800 m.

Notes. The only collection from Celebes, KJELLBERG 3527a (BO, S-PA) is not well developed and also resembles *L. orbiculata* var. *commixta*.

The specimens from the continent North of the Malay Peninsula have more intramarginal indusia and are in several respects close to *L. chienii* CHING; there is probably some introgression between the two species.

6. *Lindsaea media* R.Br. Prod. Fl. Nov. Holl. (1810) 156. — *Schizoloma medium* (R.Br.) KUHN, Chaetopt. (1882) 346. — *Schizoloma ensifolium* (SWARTZ) J. SMITH var. *medium* (R.Br.) DOMIN, Bibl. Bot. 20 (1915) 78. — Type: R. BROWN s.n., N. coast of Australia (K; several other authentic, possibly isotype coll. in K, P, U).

*L. subtripinnata* COPELAND, J. Arn. Arb. 24 (1943) 441. — Type: BRASS 8491, Tarara, W. Div., Papua (MICH; dupl. in BO, GH, L). — Fig. 20.

*Rhizome* rather long-creeping, 1–1½ mm  $\sigma$ , rather thinly and deciduously scaly; scales yellow, ovate-triangular, to c. 1 mm long, to 6-seriate at base, a short apical portion uniseriate. Leaves to ½ cm apart; *petioles* stramineous to fawn-coloured, 10–40 cm long, mostly longer than the lamina, abaxially terete below, upward gradually obtusely or acutely bi-angular and flattened. *Lamina* herbaceous or chartaceous, 10–30 cm long, 4–17 cm wide, 2–3 times as long as wide, triangular or oblong, bipinnate or bipinnate + pinnatifidate or bipinnate + pinnatifid, rarely tripinnate at base; leaf apex gradually of simpler structure. *Primary rachis* abaxially flattened, bi-angular. *Pinnae* spreading or slightly ascending, the major ones c. 4–10 to a side, most or all subopposite, the largest, basal ones 2½–10 cm long and 12–18 mm wide, not narrowed at the base, rather evenly narrowed in the upper half or throughout; secondary rachises abaxially flattened, bi-angular, green-margined to the base or almost so. *Basal pinnules* on both sides of lower pinnae of large leaves usually pinnatifidate to



Fig. 20. *Lindsaea media* R.Br. Lamina,  $\times \frac{2}{5}$  (BRASS 8491).—Fig. 21. *L. bouillodii* CHRIST. Lamina,  $\times \frac{2}{5}$  (CUMING 399).—Fig. 22. *L. bakeri* (C. CHR.) C. CHR. var. *bakeri*. Lamina,  $\times \frac{2}{5}$  (BRASS 13651). — Fig. 23. *L. roemeriana* ROSENSTOCK. Leaf,  $\times \frac{2}{5}$  (v. RÖMER 1137).

pinnatifid, rarely fully pinnate, then with few pinnules. *Ultimate pinnules* variable in size and shape, largely depending on the degree of dissection of and their place in the lamina, but distinctly dimidiate-subflabellate; larger ones trapezoidal, subquadratic, sessile, the larger, not dissected ones up to 5 by  $3\frac{1}{2}$  to 10 by 6 mm, if dissected the smaller ones with incisions only on the acroscopic side, the larger ones on both sides. *Upper pinnules* reduced, not strongly so in paucijugate pinnae; the terminal segment then obliquely rhombic, obtuse, free or almost so, to 5 mm long, more strongly reduced in plurijugate pinnae, the upper pinnules denticuliform, confluent into a narrow, pinnatifid pinna-apex. Margin of sterile pinnules sharply dentate, of fertile ones obscurely or mostly distinctly erose. Veins immersed, usually not evident, 1-3 times forked, c.  $\frac{1}{2}$  mm apart, free, connivent, or sporadically and irregularly anastomosing; leaves of adult plants hardly ever without any anastomoses, but often many pinnules, especially smaller ones, quite free-veined. *Sori* continuous except as interrupted by incisions of the margin; indusium pale, erose to gashed, almost reaching to slightly exceeding the margin, 0.3-0.5 mm wide, not reflexed at maturity. Spores medium brown, trilete, smooth, c. 25  $\mu$ .

Distr. N. Queensland; *Malesia*: Papua (one coll., type of *L. subtripinnata*).

Ecol. Bank of gully in rain forest (Papua); grassy places and forests, 0-425 m (Australia).

7. *Lindsaea heterophylla* DRYAND. Trans. Linn. Soc. 3 (1797) 41, pl. 8 f. 1.—*Adiantum heterophyllum* (DRYAND.) POIRET, Encycl. Suppl. 1 (1810) 139, non COLENSO (1888).—*Schizoloma heterophyllum* (DRYAND.) J. SMITH, Hook. J. Bot. 3 (1841) 414; HOLTTUM, Rev. Fl. Mal. 2 (1954) 345.—*L. ensifolia* SWARTZ var. *heterophylla* (DRYAND.) BENTH. Fl. Austr. 7 (1878) 722.—*Schizoloma ensifolium* (SWARTZ) J. SMITH var. *heterophyllum* (DRYAND.) DOMIN, Bibl. Bot. 20 (1915) 77.—*Schizolegria heterophylla* (DRYAND.) ALSTON, Bot. Soc. Brot. II, 30 (1956) 24.—non *L. heterophylla* PRENTICE (1873).—Type: ROBERTSON s.n., Malacca (BM).

*L. variabilis* HOOKER & WALKER ARNOTT, Bot. Beech. Voy. (1838) 257, pl. 52.—Type: MILLETT s.n., Macao (n.v.).—Fig. 17, 18.

*Rhizome* rather to very short-creeping,  $1\frac{1}{2}$ -3 mm  $\phi$ ; scales medium brown, very narrowly triangular, to 2 $\frac{1}{2}$  mm long, to 7-seriate at base, long-acuminate, the apical uniseriate part rather long. Leaves close; *petioles* (3-)10-50 cm long,  $\frac{1}{2}$ -2 times as long as the lamina, stramineous to dark brown, adaxially often paler, abaxially bi-angular, sharply so above, sometimes pale-angled. *Lamina* simply pinnate to bipinnate or rarely to subtripinnate, narrowly oblong or oblong or, especially if bipinnate, deltoid, (6-)10-45 cm long, (3-)6-20 cm wide, 2-6 times as long as wide, with 4-25 primary divisions to a side. Primary rachis mostly stramineous, abaxially sharply bi-angular or broadly and shallowly sulcate.

*Primary pinnae* rather remote, the upper ones closer, spreading or, if pinnate, ascending, herbaceous to chartaceous, medium green or olivaceous when dry. *Simple primary pinnae* lanceolate or elongate-triangular or the smaller ones rhombic, the base unequal, basiscopically narrower, acroscopically in extreme cases cordulate, the larger ones 2-10 cm long,  $\frac{3}{4}$ -1 $\frac{1}{2}$  cm wide,  $1\frac{1}{2}$ -8 times as long as wide; larger pinnate primary pinnae 8-18 cm long, ( $\frac{3}{4}$ -)1 $\frac{1}{2}$ -6 cm wide, 2-9 times as long as wide, triangular to linear, with 1-15 pinnules, these  $\frac{1}{2}$ -5 cm long, cuneate-subflabellate to suborbicular or of the same shape as undivided primary pinnae, spreading or somewhat ascending; secondary rachises abaxially subterete to bi-angular, stramineous, or reddish and pale-margined, at least upward green-margined. *Upper pinnae* of lamina gradually reduced, the upper ones usually rhombic, subacute or obtuse, less often suborbicular or flabellate, usually not less than  $\frac{1}{2}$  cm long, a few connected with the mostly comparatively large, lanceolate or elongate-triangular, obtuse to acuminate terminal segment; apices of pinnate pinnae similar. *Pinnate pinnae*, if any, occurring basally in the lamina, but sometimes above pinnae of simpler structure, but not as irregularly arranged as sometimes in *L. orbiculata*. Transitions between pinnate and simple pinnae usually paucijugate-pinnate with large terminal segment rather than lobed to pinnatifid. *Margin* of sterile pinnules (very rare in adult plants) crenate-dentate to subentire; fertile margin subentire or mostly  $\pm$  erose, little sclerotic. *Ultimate divisions*, if elongate, with a percurrent, distinct, stramineous, abaxially prominent costa; veins oblique, less so towards the margin, 1-3 times forked, immersed but evident, irregularly anastomosing, forming (except in the bases of large pinnae) an interrupted series of areoles  $\frac{1}{2}$ -1 mm wide (very rarely a second series), or free, but scarcely a leaf without any anastomoses. *Sori* continuous except as interrupted by the incisions, in pinna-apices sometimes interrupted by serrations, in lobed pinnae often extending close to or around the bottom of the sinus. Indusium pale, entire to erose, 0.3-0.5 mm wide, falling short of the margin by half its width to reaching it, little reflexed at maturity. Spores



Map 3. Distribution of *Lindsaea heterophylla* DRYAND.

pale yellowish, trilete, smooth, c. 30  $\mu$  (sometimes irregular and apparently abortive, which might be connected with hybrid origin).

Distr. Mascarene Is., Madagascar; S. India, Ceylon, Ryu Kyu Is., SE. China, to *Malesia*: Malay Peninsula, Sumatra, West Java, Bawean, Borneo (Sarawak, Sabah), Philippines (Luzon, Mindanao), Ambon; much less common than the closely related *L. ensifolia*. Map 3.

Ecol. In open to somewhat shaded, mostly moist places, up to 1100 m, mostly at lower altitude.

**8. *Lindsaea ensifolia*** SWARTZ in Schrader, J. Bot. 1800<sup>2</sup> (1801) 77; COPELAND, Fern Fl. Philip. 1 (1958) 113; KRAMER, Blumea 15 (1968) 564.—*Adiantum ensifolium* (SWARTZ) POIRET, Encycl. Suppl. 1 (1810) 139.—*Schizoloma ensifolium* (SWARTZ) J. SMITH, Hook. J. Bot. 3 (1841) 414; BACKER & POSTHUMUS, Varenfl. Java (1939) 110, f. 20; TARDIEU-BLOT & C. CHR. Fl. Gén. I.-C. 7 (1939) 129, f. 15 1-2; HOLTTUM, Rev. Fl. Mal. 2 (1954) 346, f. 200.—*Schizolegnia ensifolia* (SWARTZ) ALSTON, Bol. Soc. Brot. II, 30 (1956) 24.—Type: coll. unknown, Mauritius (S-PA).

*Pteris stricta* POIRET in Lamk, Encycl. 5 (1804) 713.—*L. pteroides* DESVAUX, Prod. (1827) 312.—Type: COMMERSON s.n., Mauritius ('Île de France') (P).

*L. lanceolata* LABILL. Nov. Holl. Pl. Sp. 2 (1806) 98, pl. 248 f. 1.—*Adiantum lanceolatum* (LABILL.) POIRET, Encycl. Suppl. 1 (1810) 134, non FÉE (1852).—*Schizoloma lanceolatum* (LABILL.) PRESL, Tent. Pterid. (1836) 132.—*Schizoloma ensifolium* (SWARTZ) J. SMITH var. *lanceolata* (LABILL.) R. BONAPARTE, Notes Ptérid. 13 (1921) 259.—*Schizoloma billardieri* GAUD. Ann. Sc. Nat. 3 (1824) 508, nom. superfl.—*L. billardieri* (GAUD.) CARRUTHERS ex SEEMANN, Fl. Vit. (1873) 337.—Type: LABILLARDIÈRE s.n., Cape Van Diemen, Australia (P; identity of specimen uncertain).

*L. erecta* MIRBEL in Lamk & Mirbel, Hist. Nat. Vég. 5 (1803) 126, non METTENIUS (1861).—Type: coll.?, Réunion (n.v.).

*Pteris angulata* PRESL, Rel. Haenk. 1 (1825) 54, nom. illeg., incl. *L. lanceolata* LABILL.—Type: coll.?, Marianas (n.v.).

*L. membranacea* KUNZE, Linnaea 18 (1844) 121.—Type: GUEINZIUS s.n., Port Natal, S. Africa (B; dupl. in BM, HBG, L, P, W).

*L. sublobata* KUNZE, Linnaea 18 (1844) 121.—Type: CUMING 369, Malacca (B; dupl. in GH, L, SING, W).

*L. griffithiana* HOOKER, Sp. Fil. 1 (1846) 219, pl. 68B.—*Schizoloma griffithianum* (HOOKER) FÉE, Gen. Fil. (1852) 108.—Type: GRIFFITH s.n., Mergui, Burma (K).

*L. pentaphylla* HOOKER, Sp. Fil. 1 (1846) 219, pl. 67A.—*Schizoloma pentaphyllum* (HOOKER) FÉE, Gen. Fil. (1852) 108.—Type: BYNOE s.n., Australia ('New Holland') (K).

*L. oligoptera* KUNZE, Bot. Zeit. (1846) 445.—Type: ZOLLINGER 1513 ('& 1515'), Java (B; dupl. in HBG, L, Z).

*Schizoloma javae* FÉE, Gen. Fil. (1852) 109, pl. 29 f. 1.—Type: ZOLLINGER 1504, Java (n.v.).  
*L. schizoloma* ETTINGSH. Farnkr. 3 (1865) 213, pl. 145 f. 4, pl. 146 f. 6.—Type: not cited; perhaps a new name for *Pteris stricta* POIRET (vide supra).

*Schizoloma heterophyllum* (DRYAND.) J. SMITH var. *speluncae* COPELAND, Philip. J. Sc. 5 (1910) Bot. 284.—Type: FOXWORTHY 578, Sandakan (MICH).

*Schizoloma ensifolium* (SWARTZ) J. SMITH var. *attenuatum* DOMIN, Bibl. Bot. 20 (1915) 77, with *f. typicum* DOMIN, type: C. B. CLARKE s.n., several coll. from India; *f. pteroides* DOMIN, types: GRIFFITH 173, Mergui, Burma, and WALLICH s.n., Singapore; *f. praelongum* DOMIN, types: KUNSTLER 1881, Singapore, and coll.?, Mauritius (n.v.).

*Schizoloma ensifolium* (SWARTZ) J. SMITH var. *borneense* DOMIN, l.c.—Type: coll.?, Borneo (n.v.).

*Schizoloma ensifolium* (SWARTZ) J. SMITH var. *clarkeanum* DOMIN, l.c. 76.—Type: CLARKE s.n., N. India (n.v.).

*Schizoloma ensifolium* (SWARTZ) J. SMITH var. *longipinnum* DOMIN, l.c. 76, with *f. typicum* DOMIN, type: GOMEZ s.n., Javoy, India; *f. sub-simplex* DOMIN, types: GRIFFITH s.n., Malacca, and WALLICH 92, Ceylon; *f. griffithianum* DOMIN, l.c. 77, type: GRIFFITH s.n., Mergui, Burma (n.v.).

*Rhizome* short- to mostly not very short-creeping. *Lamina* mostly simply pinnate, with up to c. 15 pinnae to a side. *Pinnae* lanceolate to linear, with almost symmetric base, non-dimidiolate, with percurrent costa; veins immersed,  $\pm$  evident, very oblique near the costa, less so outward, regularly anastomosing even in narrow pinnae, with 1 or 2, rarely 3-5 rows of areoles between costa and margin. *Sori* continuous; indusium linear, pale brownish, 0.3-0.5 mm wide, almost reaching the margin. Spores trilete, smooth.

#### KEY TO THE SUBSPECIES

1. Upper pinnae gradually and strongly narrowed, gradually confluent into or at least some small ones connected with the terminal segment; sometimes bipinnate. . . . . **1. ssp. agatii**
1. Upper pinnae little reduced; lamina with a free, conform terminal pinna. . . . .
2. Rachis abaxially sharply bi-angular; sterile margin serrate, or rarely subentire . . . . . **2. ssp. ensifolia**
2. Rachis abaxially not sharply bi-angular; sterile margin entire . . . . . **3. ssp. coriacea**

**1. ssp. agatii** (BRACKENR.) KRAMER, Act. Bot. Neerl. 15 (1967) 579.—*Schizoloma agatii* BRACKENR. U.S. Expl. Exp. (1854) 216, pl. 30 f. 1.—Type: U.S. Expl. Exp. s.n., Fiji (dupl. in K).

*Schizoloma ensifolium* (SWARTZ) J. SMITH var. *intercedens* DOMIN, Bibl. Bot. 20 (1915) 80, pl. 14 f. 8, pl. 15 f. 3.—Type: DOMIN s.n., Yarraba, N. Queensland (n.v.).

*Rhizome* not very shortly creeping, 1½ mm thick; scales as in the next subspecies. Leaves

$\frac{1}{2}$ –1 cm apart. *Petioles* stramineous to reddish brown, quadrangular, often sulcate. *Lamina* often lanceolate, with c. 8–15 pinnae to a side, sometimes subbipinnate or fully bipinnate. *Pinnae* often rather strongly ascending, the major ones c. 5–10 cm by 4–7 mm, 10–15 times as long as wide, the lower ones sometimes subauriculate at base, chartaceous or firmly herbaceous, acute or subacute, not rarely some lower (but not necessarily the lowermost) pinnatifid or pinnate, their segments usually rhombic or obovate, rarely prolongate-rhombic to lanceolate, up to c. 12 to a side, decurrent and often wing-connected, the basal ones often broader. Apices of pinnatifid or pinnate pinnae with a long undivided segment. *Upper primary pinnae* gradually and strongly reduced, the uppermost ones less than  $\frac{1}{3}$  the size of the lower ones, terminal segment confluent with some reduced upper pinnae or lobed at the base. Veins in smaller secondary pinnules irregularly anastomosing; often only one row of areoles present. *Sterile margin* serrate. *Sori* continuous except as interrupted by incisions of the pinnae, in small pinnules of bipinnate leaves occupying only their outer margin. Indusium often with an irregular edge, occasionally slightly exceeding the margin. Spores light brown, c. 26  $\mu$ .

*Distr. Malesia:* Ambon, Timor and New Guinea; 2 doubtful collections from Sabah. North- and eastward to Micronesia, Queensland, New Caledonia, the Tonga Is., and Samoa.

*Ecol.* Terrestrial, very euryoecious, but not in swamps; to 1200 m.

*Notes.* In regions where this and the following subspecies occur together intermediates are not very rare.

*L. ensifolia ssp. agatii* has often been confused with *L. heterophylla*, e.g. by DOMIN, l.c. Bipinnate forms may closely resemble that species but may be told apart by relatively wider pinnules, notably the upper ones, and more regularly anastomosing veins. *Ssp. ensifolia* and *ssp. agatii* overlap geographically and are connected by intermediates whereas *L. heterophylla* overlaps only with *ssp. ensifolia* from which it is sharply distinct.

## 2. *ssp. ensifolia*.

*Rhizome* sometimes short-creeping, (1–)  $1\frac{1}{2}$ –2 (–2  $\frac{1}{2}$ ) mm  $\sigma$ ; scales light reddish brown, narrowly triangular, to 2 mm long, to 5-seriate at the base, about the apical  $\frac{1}{3}$  uniseriate. Leaves to 2 cm apart. *Petioles* c. 10–35 cm long,  $\frac{1}{2}$ –1 times as long as, rarely longer than the lamina, stramineous to reddish brown, rarely darker, abaxially at least upward bi-angular and sometimes also sulcate, if dark not or hardly pale-margined. *Lamina* very variable, c. 15–45 cm long, mostly once pinnate, rarely simple, very rarely subbipinnate; if simple lanceolate, c. 10 by  $1\frac{1}{2}$ –3 cm, or linear, c. 10 cm by 3–10 mm. Pinnate lamina with the rachis like the upper part of the petiole, abaxially sharply bi-angular and mostly also sulcate. *Lateral pinnae* one odd one to 12 to a side, most often in 2–8 pairs, not contiguous,

spreading to strongly ascending, the larger ones usually subpetiolulate, lanceolate to linear,  $\pm$  evenly narrowed from base to apex, subacute to acuminate, 10–22 cm long, 4–25 mm wide, 4 to over 25 times as long as wide (the great variability at least in part due to the presence of juvenile yet fertile plants), the base broadly to narrowly cuneate, the basiscopic side usually slightly longer and narrower. Texture herbaceous to chartaceous, rarely thicker; colour dark green or olivaceous when dry. *Sterile leaves* (not common) with fewer, relatively broader pinnae; sterile margin (in fertile pinnae often present at the apex) serrate, less often subentire. *Upper pinnae* little reduced, in large leaves c.  $\frac{1}{3}$  the size of the lower ones; terminal pinna conform, with asymmetric base, of the size of the larger lateral ones, free or slightly connected with 1 or 2 not lobe-like upper pinnae. Costa stramineous, not carinate. Areoles of veins  $\frac{1}{3}$ – $1\frac{1}{2}$  (–2) mm wide. *Indusium* entire, 0.4–0.5 mm wide, strongly reflexed and concealed at maturity. Spores light yellow, c. 25–28  $\mu$ .

*Distr.* Uncommon near the coasts of W. and E. Africa; Madagascar and Mascarenes, Seychelles; S. and E. India, Ceylon, Ryu Kyu Is., SE. China to *Malesia*: throughout, including some of the Lesser Sunda Is., but rare and local in the Philippines, Celebes, and most of New Guinea; Micronesia, tropical Australia, to the Solomon Is. and New Caledonia, Hawaii.

*Ecol.* Terrestrial or epilithic, in swampy to moderately dry places, exposed or in light shade, from sea-level up to 1000 (rarely up to 1750) m; common in most parts of its Asiatic area.

*Note.* Various authors, notably DOMIN, l.c., tried to classify the confusing array of forms in this subspecies. These are, however, connected by all kinds of intermediates and defy description. The lamina of simple forms probably represents the terminal pinna.

**3. *ssp. coriacea* (v.A.v.R.) KRAMER**, *Blumea* 15 (1968) 564.—*Schizoloma coriaceum* v.A.v.R. Bull. Dép. Agr. Ind. Néerl. 18 (1908) 10.—Type: HALLIER 1934, between S. and G. Kenepai, Kalimantan, Borneo (BO).

*Rhizome* 2–3 mm  $\sigma$ , mostly not short-creeping; scales to 2  $\frac{1}{4}$  mm long, to 8-seriate at the base, with a short uniseriate apex. *Petioles* atropurpureous, shining, abaxially terete or upwards obtusely carinate. *Lamina* rarely simple, mostly once pinnate, with 1–5 pinnae to a side and a conform terminal one. Rachis like the petiole, abaxially terete or obtusely carinate, rarely obtusely bi-angular. *Pinnae* lanceolate, acute or acuminate, chartaceous or subcoriaceous, 10–25 cm long, 1–2  $\frac{1}{2}$  cm wide, 6–15 times as long as wide, widest above the scarcely unequal base, not rarely sterile, then entire; terminal pinna the largest. Costa stout, stramineous to dark brown. Areoles in 2 or 3 rows, often to 2 mm wide. *Indusium* entire, usually not over 0.3 mm wide. Spores yellowish brown, trilete, smooth, c. 20  $\mu$ .

*Distr. Malesia:* Johore, Singapore, Riouw

Is., Sumatra, Borneo (Sarawak, Kalimantan); a single collection doubtfully from Java.

Ecol. In swamp forests, on acid soil.

Note. It is feasible that the criterium of the rachis structure used here for distinguishing *ssp.*

*coriacea* from the exceedingly variable *ssp. ensifolia* is not entirely reliable. There are a few collections that match *ssp. coriacea* in other characters but have abaxially  $\pm$  pronouncedly bi-angular axes.

## 2. Section *Temnolindsaea*

KRAMER, Act. Bot. Neerl. 6 (1957) 176.

Type species: *Lindsaea klotzschiana* MORITZ.

Distr. Neotropical, and 7 *ssp.* in Malesia and New Caledonia.

Taxon. The short-creeping rhizome, bipinnate lamina with conform terminal pinna, dimidiate free-veined pinnules, interrupted sori, and trilete spores are characters of all species. Otherwise the paleotropical species do not have very much in common with the neotropical ones, and it may well be that they are more closely related to *sect. Synaphlebium*.

9. *Lindsaea kingii* COPELAND, Philip. J. Sc. 6 (1911) Bot. 83; *ibid.* 78 (1949) 19.—Type: KING 241, Papua (MICH; fragm. in BM).—Fig. 25.

*Rhizome* short-creeping, 2½–3 mm  $\sigma$ ; scales fawn-coloured, narrowly triangular, to c. 3 mm long, to 18-seriate at base, with a very short apical uniseriate portion. Leaves clustered; *petioles* quadrangular with channelled sides, stramineous to olivaceous brown, their lateral faces with a series of median elongate pale pustules, 10–25 cm long, ½–½ as long as the lamina. *Lamina* to c. 70 cm long, with 5–11 major lateral pinnae to a side, a similar terminal one, and 1–5 strongly reduced basal ones. Primary rachis like the petiole, sometimes also with pustules, the adaxial groove with thick pale ridges. *Pinnae* alternate, ascending, subsessile, linear, the major ones 10–20 by 1½–2 cm, broadest at base or in the basal third, evenly narrowed to the subacute to shortly acuminate apex. Secondary rachises abaxially brownish in the lower, pale in the upper part or throughout, abaxially bi-angular except for a short basal portion. *Pinnules* 25–35 to a side, alternate, subcontiguous to half their width apart, subsessile, herbaceous, medium or dark green when dry, slightly ascending, subtrapezoidal to semi-ovate, the upper edge convex and without an outer edge, or the upper edge straight and with a distinct outer edge; larger pinnules 9–10 by 4–5 mm. Upper/outer margin with about 4 incisions to 2 mm deep, with very narrow sinus; sterile pinnules with alternating deeper and shallower incisions; margin otherwise entire. Upper pinnules strongly reduced, denticuliform. *Reduced basal pinnae* with a few almost or quite sterile pinnules. Veins immersed, evident, once or twice forked, free. *Sori* interrupted by the incisions of the margin, usually binerval (uni- to quadrinerval); receptacle laterally exceeding the soral veins. Indusium pale, entire or nearly so, with straight or slightly convex base, often c. 1 mm long, 0.3 mm wide, narrowed at the ends, not reaching the edge by about its own width, little reflexed at maturity. Spores pale brown, smooth, trilete, c. 30  $\mu$ .

Distr. *Malesia*: Moluccas (Morotai, Ceram), New Guinea (all Div.), Schouten I., Waigeu, d'Entrecasteaux Is., Admiralty Is. (Manus),

Solomon Is.

Ecol. In forests, terrestrial and on logs, 30–1000 m.

Note. The reduced basal pinnae of bipinnate leaves are unique in the genus.

10. *Lindsaea multisora* v.A.v.R. Bull. Jard. Bot. Btzg II, 16 (1914) 21.—Type: RACHMAT (exp. VAN VUUREN) 669, Mt Lambolo, Celebes (BO; dupl. in L).

*L. kjellbergii* C. CHR. Bot. Jahrb. 66 (1933) 53.—Type: KJELLBERG 3615, Malili, Celebes (S-PA; dupl. in BM, BO).—Fig. 27.

*Rhizome* short-creeping, c. 2 mm  $\sigma$ ; scales reddish brown, narrowly triangular, to 2 mm long, to c. 8-seriate at the sometimes rather suddenly broadened base, the apical ⅓ or ¼ uniseriate. Leaves close; *petioles* stramineous, sharply quadrangular and shallowly sulcate, 10–30 cm long, about as long as the lamina. *Lamina* oblong, 15–30 cm long, bipinnate (in juvenile yet partly fertile plants simply pinnate), with 1–4 pinnae to a side and a conform terminal one. Primary rachis similar to the petiole. *Pinnae* 10–15 cm long, 9–16 mm wide, obliquely ascending, subopposite, sessile, widest in the lower half, gradually and strongly acuminate. Secondary rachises abaxially sharply bi-angular almost to the base, shallowly sulcate. *Pinnules* c. 25–40 to a side, close, subcontiguous, subsessile,  $\pm$  ascending, especially the upper ones, herbaceous, dark green or olivaceous when dry, approximately semi-ovate in outline, the larger ones 7–8 by 2½–3 mm, without a distinct outer margin, the lower margin usually convex, the upper margin with mostly 3 major incisions reaching down to the middle or a little less, the basal lobes often, the other ones occasionally again incised; lobes, especially the outer ones, often oblique, mostly ¾–1 mm wide, approximately parallel-sided, truncate or faintly convex and slightly erose if fertile, narrowed-rounded if sterile, the wing joining the lobes c. 1 mm wide. *Upper pinnules* gradually and strongly reduced, confluent into the narrow pinna-apex. Veins immersed, evident, 2 or 3 in the larger lobes, single in the smaller ones. *Sori* usually bi- or trinerval (uni- to quadrinerval); indusium thin, pale, entire, 0.3–0.4 mm wide, not quite reaching

the margin,  $\pm$  reflexed at maturity. Spores pale yellowish, trilete, smooth, c. 22  $\mu$ .

Distr. *Malesia*: Celebes (2 coll.).

Ecol. Terrestrial in rain-forest, 100 m.

**11. *Lindsaea natunae* BAKER**, Kew Bull. (1896) 40.—Type: Hose 315, Natuna Is. (K; dupl.? in E, SAR).

*L. canaliculatifera* v. A.V.R. Bull. Jard. Bot. Btzig III, 5 (1922) 211.—Lectotype: BÜNNEMEIER 5835, Riouw (BO; dupl. in K, L, P, SING, U; fragm. in US).—Fig. 26.

*Rhizome* rather short-creeping, 2 mm  $\phi$ ; scales reddish brown, narrowly triangular, acuminate, to 2½ mm long, to c. 10-seriate at base, the apical uniseriate part relatively short. Leaves rather close; *petioles* 8–35 cm long, about equaling the lamina, stramineous to fawn-coloured, quadrangular, with paler edges,  $\pm$  sulcate. *Lamina* bipinnate (rarely subtripinnate), with 3–5 pinnae to a side and a conform terminal one. Primary rachis similar to the petiole, abaxially narrowly channelled. *Pinnae* obliquely ascending, not close, subsessile, 10–15 cm long, 1½–2½ cm wide, narrowed in the upper ½, the upper ones little shortened; basal pinnae rarely with 1 or 2 basal pinnate secondary pinnae. Secondary rachises abaxially bi-angular. *Pinnules* c. 20–30 to a side, mostly not contiguous, herbaceous, dark green when dry, semi-ovate to subtrapeziform, subsessile, 9 by 3 to 12 by 4½ mm, 2½–3 times as long as wide, the lower margin  $\pm$  straight, the upper straight or slightly convex, a distinct outer margin not or scarcely developed. *Upper pinnules* gradually and strongly reduced, several denticuliform ones connected with the narrow terminal segment. Upper margin of pinnules mostly with 3 oblique incisions which scarcely reach farther than ¼ but get slightly deeper towards the apex of the pinnule; outer margin without or with one incision. *Larger pinnule lobes* with a straight or sinuate outer margin, laterally somewhat convex; sinus acute. Veins immersed, evident, mostly once forked. *Sori* one per lobe, mostly binerval, laterally exceeding the vein-ends; indusium entire, ¼–⅓ mm wide, almost or quite reaching the margin, scarcely reflexed at maturity. Spores pale brown, trilete, smooth, c. 28  $\mu$ .

Distr. *Malesia*: Natuna Is. (3 coll.), Riouw (2 coll.).

Ecol. Terrestrial in forests, 500–1000 m.

**12. *Lindsaea tetragona* KRAMER**, Blumea 15 (1968) 564.—*L. tenuifolia* auct. non BLUME, with syn., of other authors, in part.—Type: BINNENDIJK 160, Ambon (U).

*Rhizome* short-creeping, 1½–2 mm  $\phi$ ; scales reddish or yellowish brown, narrowly triangular, to 1¾ mm long, to c. 4-seriate, the uniseriate apex short. Leaves close; *petioles* stramineous or mottled with age, quadrangular and sulcate, 10–30 cm long, about as long as the lamina. *Lamina* c. 10–40 cm long, oblong, bipinnate, with 3–9 pinnae to a side and a conform terminal one; primary rachis like the petiole. *Pinnae*

sessile, obliquely ascending, not close, 8–15 cm long, 17–25 mm wide, gradually to rather suddenly narrowed at apex. Secondary rachises stramineous, abaxially bi-angular, with a flat channel. *Pinnules* c. 20–45 to a side, herbaceous, mostly pale green when dry, close but usually not contiguous, somewhat ascending; lower margin often concave. Upper/outer margin deeply incised, at least the outer incisions reaching the middle of the pinnule, very oblique. Lobes linear, parallel-sided, the larger ones often forked. Sterile lobes narrowed-rounded at apex, fertile ones often slightly broadened at the sorus, truncate or slightly convex. *Upper pinnules* gradually and strongly reduced, confluent with the pinnatifid, narrow pinna-apex. Veins immersed, evident. *Sori* uni- or binerval. Spores very pale brown, trilete, smooth, c. 22  $\mu$ .

#### 1. var. *tetragona*.

Lobes of pinnules ⅓–¾ (rarely to 1) mm wide; pinnules incised to ⅔ or ¾ (in sterile ones less), semi-ovate to asymmetrically triangular; veins rarely two per lobe; sori rarely binerval; indusium pale, entire or sinuate, ¼–½ (to almost 1) mm long, ¼ mm wide, not reaching the margin by ¼–½ mm, strongly reflexed and concealed at full maturity.

Distr. *Malesia*: Celebes, Philippines (Mindanao), Moluccas (Talaud, Ceram, Ambon), Louisiades; Solomon Is., Fiji, Samoa, Tahiti.

Ecol. Terrestrial in forests, often by water-courses, to c. 600 m.

**2. var. *brassiana* KRAMER**, Blumea 15 (1968) 565.—Type: BRASS 27919, Sudest I., Louisiades (L; dupl. in GH).

Pinnules incised to ⅓ or ¼, only at the apex to ½, semi-ovate to subrhomboid; lobes ¾–1 mm wide, with  $\pm$  erose outer edge, often binerval; apices of pinnules often protracted into a caudiform, lobed segment; indusium erose, often not reaching the edge of the pinnule by more than its width.

Distr. Louisiades (2 coll.).

Ecol. In rain-forest, 300 m.

**13. *Lindsaea polycetena* KRAMER**, Blumea 15 (1968) 565.—*Davallia blumeana* of HOOKER, Sp. Fil. 1 (1845) pl. 54 A.—Type: CUMING 309, Philippines, Leyte (US; dupl. in B, BM, HBG, K, L, MICH, P, W).—Fig. 28.

*Rhizome* short-creeping, c. 2 mm  $\phi$ ; scales light reddish brown, elongate- to very narrowly triangular, to c. 2 mm long, up to 8-seriate at base, the uniseriate apex short. Leaves close; *petioles* stramineous, quadrangular, at least adaxially sulcate, 10–25 cm long, mostly somewhat shorter than the lamina. *Lamina* bipinnate (rarely subtripinnate), oblong, 10–30 cm long, with 3–11 pinnae to a side and a conform terminal one; primary rachis like the petiole. *Pinnae* ascending, sessile, 8–12 cm long, 1½–2 cm wide, the upper ones hardly or not shortened. Secondary rachises abaxially sharply bi-angular, the angles sometimes



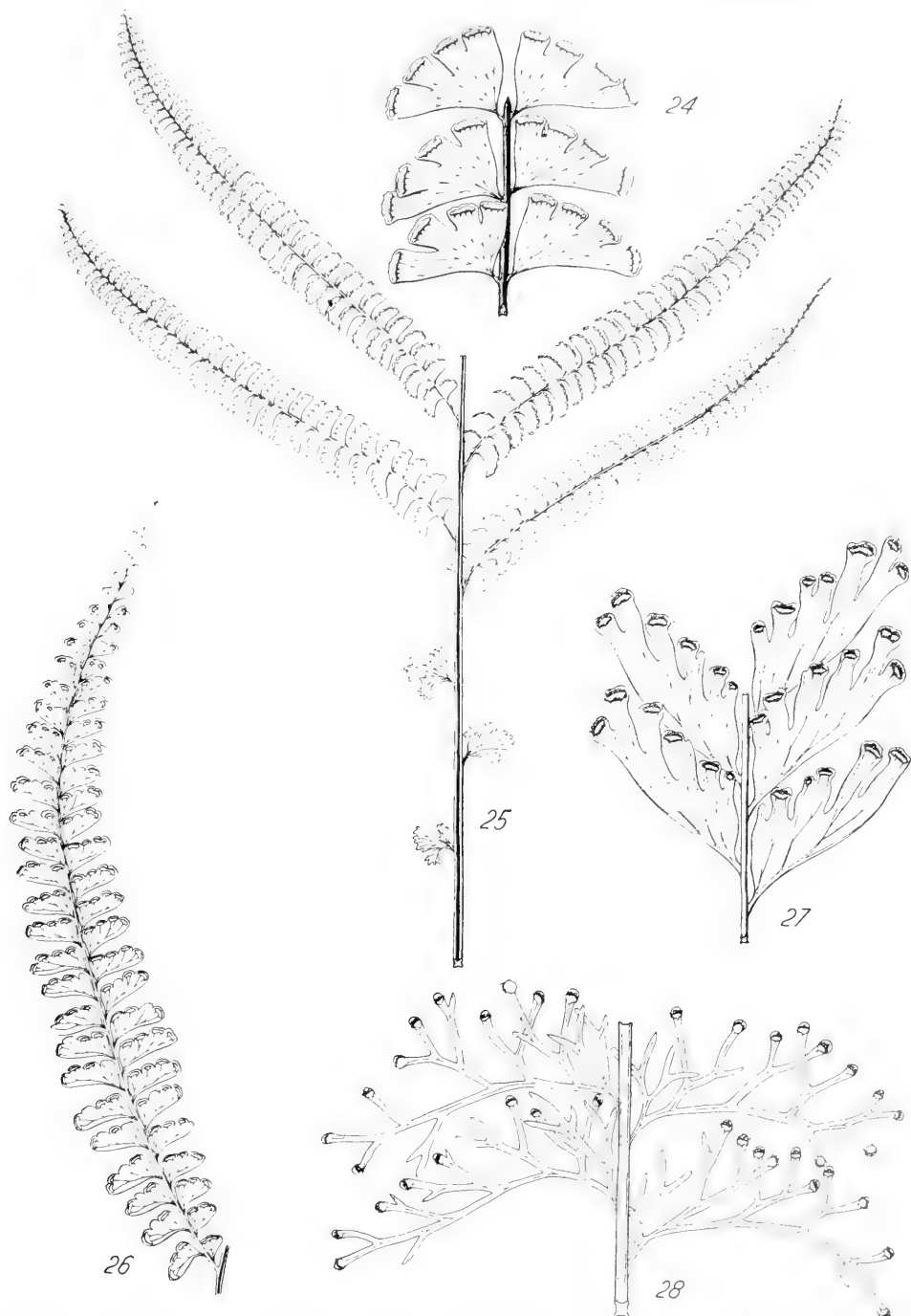
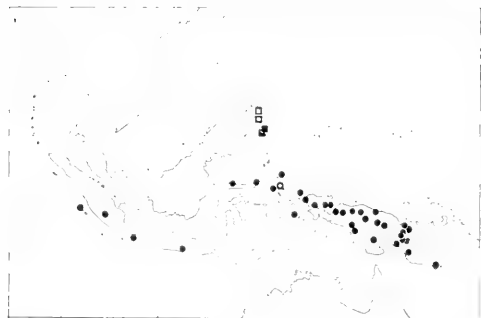


Fig. 24. *Lindsaea adiantoides* J. SMITH. Lower part of lamina,  $\times 1\frac{1}{2}$  (EDAÑO 40514).—Fig. 25. *L. kingi* COPEL. Basal part of lamina,  $\times \frac{1}{2}$  (BRASS 25622).—Fig. 26. *L. natunae* BAKER. Pinna, nat. size (BÜNNE-MEIJER 5840).—Fig. 27. *L. multisora* v.A.v.R. Part of a pinna,  $\times 3\frac{1}{2}$  (KJELLBERG 3515).—Fig. 28. *L. polyclena* KRAMER. Part of a pinna,  $\times 6$  (CUMING 309).

irregular and slightly wing-like, the face between them scarcely concave. *Pinnules* c. 20–40 to a side, mostly slightly ascending and with slightly decurved upper part, not very close, curved-narrowly triangular in outline, the largest 7–12 by 2–3 mm, thinly herbaceous, mostly dark green when dry, even the lower margin at base only very little sclerotic, deeply incised from the upper margin, mostly with 6 primary lobes, these capillary, 0.2–0.4 mm wide at base, twice as wide at apex, connected by a wing of 0.2–0.4 mm, towards the apex more oblique, in small pinnules the basal one(s) forked, in large ones all except a few apical ones forked, the basal one often twice forked and then its basal branch sometimes sterile. *Segments* slightly broadened from the base, then suddenly broadened at the sori, the outer edge truncate-convex and often irregularly erose; sterile segments subacute. Veins immersed, evident, single in the segments. *Upper pinnules* gradually reduced, confluent into a pinnatifid pinna-apex. *Sori* strictly uninerval; indusium pale, subentire to erose,  $\frac{1}{4}$ – $\frac{1}{2}$  mm long, c. 0.2 mm wide, not reaching the apical margin by 1–2 times its width, reaching the lateral margin or not, if longer with concave base, free at the sides,  $\pm$  reflexed at maturity. Spores pale brown, trilete, smooth, c. 20  $\mu$ .

Distr. *Malesia*: Philippines (Samar, Leyte, Mindanao; 8 coll.). Map 4.



Map 4. Distribution of *Lindsaea polycetena* KRAMER (squares) and *L. tenuifolia* BL. (dots).

Ecol. Terrestrial in forest; one record 60 m, one 800 m.

**14. *Lindsaea tenuifolia* BLUME**, En. Pl. Jav. (1828) 219; COPELAND, Philip. J. Sc. 78 (1949) 17; not of COPELAND, Fern Fl. Philip. 1 (1958) 110.—*Odontoloma tenuifolium* (BLUME) J. SMITH, Hook. J. Bot. 3 (1841) 415.—*Davallia blumeana* HOOKER, Sp. Fil. 1 (1845) 177 (not of pl. 54 A); non *Davallia tenuifolia* SWARTZ.—*Stenoloma blumeum* (HOOKER) FÉE, Gen. Fil. (1852) 330,

pl. 27bis A f. 2.—*Odontoloma blumeum* (HOOKER) METT. Fil. Lips. (1856) 104.—*Davallia triquetra* BAKER, Syn. Fil. ed. 1 (1867) 93.—*L. blumeana* (HOOKER) KUHN in Miq. Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 277, *nom. superfl.*—*Odontoloma triquetrum* (BAKER) J. SMITH, Hist. Fil. (1875) 269 ('*triquetra*'), *nom. superfl.*—*L. triquetra* (BAKER) CHRIST, Farnkr. d. Erde (1897) 294, *nom. superfl.*—Type: BLUME s.n., Java (L.).

*Rhizome* short-creeping, c. 2 mm  $\phi$ ; scales reddish brown, narrowly triangular, to  $2\frac{1}{2}$  mm long, to c. 10-seriate at base, with a short uniseriate apex. Leaves close; *petioles* stramineous, triangular, especially the abaxial keel pronounced, acute, (5–)15–30 cm long, mostly somewhat shorter than the lamina. *Lamina* oblong, mostly olivaceous or dark green when dry, thinly herbaceous, 10–35 cm long, bipinnate (once pinnate in juvenile but nearly always sterile plants), with 3–9 pinnae to a side and a conform terminal one. Primary rachis similar to the petiole. *Pinnae* obliquely ascending, mostly not close, sessile, 7 by 1 to 15 by 2 cm, acuminate; secondary rachises abaxially sharply carinate virtually to the base; upper pinnae little or not shortened. *Pinnules* c. 20–45 to a side, mostly rather close, often subcontiguous, spreading, slightly ascending, or occasionally somewhat falcately decurved, semi-ovate in outline, subsessile, 5–14 mm long,  $2\frac{1}{2}$ –4 mm wide, 2–3 $\frac{1}{2}$  times as long as wide; lower edge straight or  $\pm$  concave, upper edge especially towards the apex convex, a distinct outer edge scarcely developed. Pinnules deeply incised from the upper margin into 4–6 major segments, the larger ones nearly always forked, the apical one often protracted and pinnatifid; *ultimate lobes* linear, parallel-sided to near the slightly broadened apex if fertile, rounded or subacute if sterile, the outer ones progressively shorter and more oblique, rounded or erose at apex,  $\frac{1}{4}$ – $\frac{3}{4}$  mm wide, the wing joining them  $\frac{1}{2}$ –(at the base of the pinnule) 1 mm wide. *Upper pinnules* gradually and strongly reduced, confluent into a narrow, pinnatifid pinna-apex. *Veins* single or less often paired in the ultimate lobes, immersed, evident. *Sori* uni- or less often binerval; indusium pale, entire or subentire, 0.4–1 mm long, 0.2 mm wide, if short with flat or convex, if longer with concave base, reaching the margin to falling short of it by almost its width. Spores pale brown, trilete, smooth, c. 20  $\mu$ .

Distr. *Malesia*: Celebes, Moluccas (Ceram, Halmahera, Ternate, Morotai), Waigeu, New Guinea (West to East); a few collections from S. Sumatra, Sipora (Mentawai Is.), West and East Java. Map 4.

Ecol. Terrestrial and on rocks and tree bases, in forest and by watercourses, to 1000 m, mostly at lower altitude.

### 3. Section *Synaphelebium*

(J. SMITH) DIELS in E. & P. Nat. Pfl. Fam. I, 4 (1902) 221.—*Synaphelebium* J. SMITH, Hook. J. Bot. 3 (1841) 415, *nom. nud.*; in Hooker & Bauer, Gen. Fil. (1842) pl. 101.

Type species: *Synaphlebium recurvatum* HOOKER = *Lindsaea cultrata* (WILLD.) SWARTZ.  
Distr. Paletropical, from India to Taiwan, the Marquesas, and NE. Australia.

Taxon. Lamina bipinnate or subtripinnate, with conform terminal pinna, or simply pinnate; pinnales midiate, reticulate-veined; spores trilete. The rhizome is short-creeping, but it may be more long-creeping in exceptionally epiphytic specimens from moist montane habitats. Species with anastomosing veins from other sections have in the past been incorrectly assigned to this section. A few species: *L. crispa* BAKER, *L. malayensis* HOLTUM, *L. napaea* v.A.v.R., usually have irregularly, i.e. incompletely anastomosing veins, and the boundary of the section is not entirely sharp. It is particularly close to *sect. Temnolindsaea*. The delimitation of the species meets with unusual difficulties, and the present treatment should by no means be regarded as final.

**15. *Lindsaea malayensis* HOLTUM**, Gard. Bull. S. S. 5 (1930) 69, f. 8; Rev. Fl. Mal. 2 (1954) 335, f. 194.—*L. subalpina* auct. non v.A.v.R.; HOLTUM, Gard. Bull. S. S. 5 (1930) 71.—Type: Md. HANIFF 4032, G. Kerbau, Perak (SING).

*Rhizome* short-creeping, 1–2 mm  $\sigma$ ; scales medium brown, very narrowly triangular, to  $1\frac{3}{4}$  mm long, to c. 5-seriate at base, with a long uniseriate apex. Leaves clustered; *petioles* stramineous, quadrangular, abaxially broadly and shallowly sulcate or flat below, (6–)10–30 cm long, about as long as the lamina, or in small leaves shorter. *Lamina* simply pinnate or more often paucijugate-bipinnate, with one odd lateral pinna to 2 pairs and a conform terminal one; primary rachis like the petiole, abaxially often more sulcate. Lamina if simply pinnate c. 10–20 cm long and  $3\frac{1}{4}$ –4 cm wide, if bipinnate 18–30 cm long. *Primary pinnae* (if any) not strongly ascending, not close, 8–20 cm long, 2–4, often  $2\frac{1}{2}$  cm wide, mostly rather abruptly acuminate. Pinnule-bearing rachises like the primary, or abaxially more sulcate. *Pinnules* herbaceous to chartaceous, pale to dark olivaceous when dry, rounded-subtrapeziform-ligulate or less often rounded-subrectangular, spreading or  $\pm$  ascending, 12 by 4 to 20 by 6 mm,  $2\frac{1}{2}$  to almost  $3\frac{1}{2}$  times as long as wide; lower margin  $\pm$  straight, upper margin often outward convex, outer margin rounded into the upper or meeting both lower and upper at approximately right angles, the pinnules then scarcely narrowed to the subtruncate apex. Upper margin with 3–5 narrow incisions to 1 mm, occasionally to 2 mm ( $\frac{1}{3}$  of the width) deep, the lobes between them flattish, the largest rarely shallowly incised again; outer margin with 1 or without any incision; fertile margin often in addition minutely erose; sterile margin with the major incisions equally developed, the lobes crenate. *Upper pinnules* gradually or mostly rather abruptly reduced, some denticuliform ones confluent with the pinatifid terminal segment; *lower pinnules* of simply pinnate leaves often more remote. Veins immersed or adaxially slightly prominulous, evident, once or twice forked,  $\frac{1}{2}$ –1 mm apart, connivent, here and there anastomosing, or sometimes quite free, but most leaves at least with a few anastomoses, the row of areoles rarely complete in one pinnule. *Sori* interrupted by the incisions, 1–4 mm long, the one on the outer margin usually continuous with the outermost one of the upper; indusium greenish or brownish, subentire, 0.2–0.3 mm wide, not reaching the margin by an equal or

larger distance, reflexed and often quite concealed at maturity. Spores very pale brown, trilete, smooth, c. 22–25  $\mu$ .

Distr. S. Thailand, in *Malesia*: Malay Peninsula (Pahang, Perak). Incorrectly reported from Borneo (Act. Phytotax. Geobot. 22, 1966, 90).

Ecol. In mountain forests, c. 1200–2000 m.

**16. *Lindsaea napaea* v.A.v.R.** Bull. Jard. Bot. Btzg II, 20 (1915) 19, pl. 3; HOLTUM, Gard. Bull. S. S. 5 (1930) 66; Rev. Fl. Mal. 2 (1954) 330, f. 189.—Type: TEJSMANN 16616, Mt Dai, Lingga Is. (BO).

*Rhizome* short-creeping,  $1\frac{1}{2}$ –2 mm  $\sigma$ ; scales reddish brown, narrowly triangular or linear, to slightly over 1 mm long, to 6-seriate at base but often narrower, with a short uniseriate apex. Leaves close; *petioles* stramineous or darker with age, abaxially flat or convex and laterally bi-angular, with obtuse, downward gradually evanescent ridges, c. 10–30 cm long, about as long as the lamina. *Lamina* broadly ovate, c. 10–25 cm long, bipinnate (rarely simply pinnate and fertile, or subtripinnate), with 1–4 pinnae to a side and a conform terminal one; primary rachis abaxially slightly concave or upward channelled, bi-angular. *Pinnae* sessile, ascending, not close, 10–22 cm long,  $1\frac{3}{4}$ – $2\frac{1}{2}$  cm wide, gradually narrowed from the lower third or the middle but more strongly so near the apex; upper pinnae slightly or not shortened. Secondary rachises abaxially bi-angular, between the angles flat or convex. *Pinnules* c. 20–45 to a side, herbaceous, olivaceous or brownish when dry, spreading or a little ascending or slightly decurved, often subcontiguous, evenly spaced, 10–12 by 3–4 mm, ligular or trapeziform, truncate-rounded or narrowed-rounded at apex; upper margin very faintly sinuate or more often with 3 or 4 oblique incisions, the inner very shallow, the outer a little deeper but not reaching to  $\frac{1}{3}$  of the width; outer margin mostly not incised; sterile pinnules crenate-sinuate on the upper and outer margin. *Upper pinnules* strongly reduced, some denticuliform ones confluent with the caudate pinna-apex. Veins immersed, not evident, mostly twice forked,  $\frac{1}{2}$ – $\frac{2}{3}$  mm apart, very oblique, free or less often connivent or more freely anastomosing. *Sori* rarely continuous, mostly interrupted by the incisions, the sorus on the outer margin mostly continuous with the outermost one of the upper margin. *Sori* of completely fertile pinnules straight or the outer ones slightly convex, mostly on 2–6

veins. Indusium entire,  $\frac{1}{8}$ – $\frac{1}{5}$  mm wide, not reaching the margin by less than its width, reflexed and  $\pm$  concealed at maturity. Spores pale brown, trilete, smooth, *c.* 17–19  $\mu$ .

Distr. S. Peninsular Thailand, in *Malasia*: Malay Peninsula (Perak, Pahang, Penang, Selangor, Kelantan, Negri Sembilan, Kedah, Malacca), Lingga Is., W. Sumatra, Siberut.

Ecol. Terrestrial and epilithic, in mountain forests, *c.* 1000–1300 m, apparently of local occurrence.

Note. The three collections from Sumatra and Siberut have more regularly anastomosing veins than the others but are otherwise not aberrant.

**17. *Lindsaea subalpina*** v.A.v.R. Bull. Jard. Bot. Btztg II, 23 (1916) 15; not of HOLTUM, Gard. Bull. S. S. 5 (1930) 71.—Type: AJOEB 388, Rimbo Pengadang, Bencoolen, Sumatra (BO; dupl. in L).—Fig. 33.

*Rhizome* short-creeping, *c.* 2 mm  $\phi$ ; scales (few seen) reddish brown, narrowly triangular,  $\frac{2}{3}$  mm long, to 4-seriate at base, with a very short uniseriate apex. Leaves close; *petioles* stramineous to pale reddish brown, stout, quadrangular with shallowly sulcate sides, *c.* 15–30 cm long, about as long as the lamina. *Lamina* simply pinnate, linear, *c.* 15–40 cm long,  $4\frac{1}{2}$ – $5\frac{1}{2}$  cm wide; rachis similar to the petiole. *Pinnules* *c.* 12–30 to a side, spreading or slightly ascending, firmly herbaceous, mostly dark green when dry, usually not contiguous, elongate-parallelgram-shaped to ligular, 2 by 0.6 to  $3\frac{1}{2}$  by 1 cm,  $3\frac{1}{2}$ –3 times as long as wide, subsessile, little narrowed to the apex, this rounded or occasionally caudate-protruded; upper margin with 5–7 major incisions, these rather oblique, reaching  $\frac{1}{4}$ – $\frac{1}{3}$  down, narrow, the largest lobes sometimes more shallowly incised again; lobes slightly convex, often erose. Sterile pinnules not seen. Relatively few *upper pinnules* reduced, mostly one of *c.*  $\frac{3}{4}$  cm adnate to the narrow, lanceolate, lobed terminal segment. Veins immersed but evident, especially above, very oblique, regularly anastomosing, often with 2 series of areoles between the two margins, almost 1 mm apart at the vein-bases. *Sori* single in the lobes, usually on 4–8 veins, the one on the outer margin often continuous with the outermost of the upper; indusium pale, erose,  $\frac{1}{4}$ – $\frac{1}{3}$  mm wide, not reaching the margin by about the same distance or less, reflexed and  $\pm$  concealed at maturity. Spores pale brown, trilete, smooth, *c.* 19–22  $\mu$ .

Distr. *Malasia*: Sumatra (Bencoolen, 5 coll., West Java (1 coll.)).

Ecol. Terrestrial in forest, 600–1000 m.

**18. *Lindsaea obtusa*** J. SMITH in Hooker, Sp. Fil. 1 (1846) 224.—Type: CUMING 394, Malacca (K; dupl. in B, E, GH, P, W).

? *L. tripartita* BLUME, En. Pl. Jav. (1828) 219.—Type: BLUME *s.n.*, Java (L).

? *L. ambigua* CESATI, Rendic. R. Accad. Sci. Fis. Mat. Napoli 16 (1877) 25, *nom. subnud.*—Type: BECCARI *s.n.*, Andai, Papua (*n.v.*).

*L. schultzei* BRAUSE, Bot. Jahrb. 49 (1912) 29.—

Type: SCHULTZE 3049, Sepik R., Terr. of New Guinea (B).

*L. decomposita* WILLD. *f. minor* v.A.v.R. Bull. Jard. Bot. Btztg II, 7 (1912) 21.—Type: KING 48 'p.p.', Papua (BO).

*L. ceramica* v.A.v.R. Bull. Jard. Bot. Btztg II, 28 (1918) 32.—Type: KORNASSI 707, Ceram (BO).

? *L. sinuato-crenata* v.A.v.R. Nova Guinea 14 (1924) 30; COPELAND, Philip. J. Sc. 78 (1949) 20.—Type: H. J. LAM 1888, mountain ridge near Doormantop, W. New Guinea (L).

*L. decomposita* WILLD. *f. longipinnula* v.A.v.R. Nova Guinea 14 (1924) 30.—Type: H. J. LAM 1163, near Prauwenbivak, Mamberamo R., W. New Guinea (BO; dupl. in L).

*L. furcata* COPELAND, Un. Cal. Publ. Bot. 18 (1942) 218; Philip. J. Sc. 78 (1949) 21, pl. 4.—Type: BRASS 13229, Bernhard Camp, Idenburg R., W. New Guinea (MICH; dupl. in GH, L).

*L. decomposita* auct. non WILLD.; COPELAND, Philip. J. Sc. 78 (1949) 20.

*L. davallioides* auct. non BLUME; HOLTUM, Gard. Bull. S. S. 5 (1930) 69, f. 7; Rev. Fl. Mal. 2 (1954) 332, f. 190.—Fig. 31.

*Rhizome* short-creeping, 1–2½ mm, usually 1½ mm  $\phi$ ; scales medium brown, narrowly triangular, to 1½ mm long, to 4-seriate at base, with a rather short uniseriate apex. Leaves close (less so in epiphytic plants); *petioles* stramineous or in mature specimens mostly medium to dark brown or blackish, sometimes pale-margined or mottled,  $\pm$  sharply quadrangular and mostly somewhat sulcate, *c.* 10–30 cm long,  $\frac{1}{2}$  as long as to equaling the lamina. *Lamina* simply pinnate or in full-grown plants mostly bipinnate, with 1 or 2, less often with 3 pairs of pinnae (very rarely the basal pinnae forked) and a conform terminal one; primary rachis like the petiole. *Pinnae* mostly subopposite, obliquely ascending, 10–20 cm long,  $1\frac{1}{2}$ –3 cm wide (simply pinnate laminas may be wider), widest in the lower half, gradually and strongly narrowed to the usually long-acuminate apex; secondary rachises abaxially bi-angular, mostly distinctly sulcate, usually pale. *Pinnules* herbaceous to chartaceous, mostly rather dark when dry, *c.* 20–35 to a side, mostly distinctly ascending, close but hardly contiguous, the basal ones of simply pinnate leaves often more remote, ligulate to subtrapeziform, the larger ones 10–16 mm long and 5–7 mm wide, nearly always slightly over twice as long as wide, narrowed from the base to the broadly rounded or subtruncate apex, less often of almost equal width from base to apex, the upper margin straight at the base, outward convex. *Upper pinnules* gradually and strongly reduced, mostly some denticuliform ones present below the crenate-pinnatifid apex. Upper and outer margins of pinnules incised, mostly with 3–5 narrow, oblique incisions usually less than 1 mm (but in extreme cases to 2 mm) deep; margin otherwise minutely but distinctly crispate and/or erose. Lobes of fertile pinnules, especially the inner ones, flat, truncate, not convex. Veins immersed and often obscure, mostly twice

forked, regularly anastomosing, forming one or sometimes towards the apex of the pinnule two series of areoles; larger areoles to 1 mm wide. *Sori* interrupted by the incisions, variable in size, the innermost one often quadrinerval, the outer ones bi- or trinerval, but often on more or fewer vein-ends. Indusium subentire or, if broader, often crose, very variable in width, 0.2–0.7 mm wide, not reaching the margin by  $\frac{1}{2}$ –1 times its width, bulging but hardly reflexed at maturity. Spores pale yellowish, trilete, smooth, c. 24  $\mu$ .

Distr. Taiwan; throughout *Malesia* (but absent from the Lesser Sunda Is. except Bali), east to the Solomon Is. and the Bismarck Archipelago; Micronesia, Queensland.

Ecol. In primary forest, often on banks, on rocks, by or on tree bases, from sea-level up to 2000 m, mostly below 1500 m.

Notes. As defined here this is one of the most common and widespread species of SE. Asia. It is exceedingly variable, and the extremes look quite distinct. In E. *Malesia* and W. Melanesia a form occurs with indusia 0.2–0.35 mm wide, less than half their width removed from the edge, pinnule lobes not rarely concave and then sometimes laterally subcorniculate, thinner texture, and truncate, subrectangular pinnules; it may represent a distinct infraspecific taxon. It occurs, however, together with the more widespread form, with large numbers of intermediates, and classification on the basis of herbarium material alone seems at present impossible.

The type of *L. tripartita* BLUME is largely sterile, and it is impossible to ascertain which species it really represents. The type of *L. sinuato-crenata* v.A.v.R. is a diseased or for another reason malformed leaf; it probably belongs to the present species. The type of *L. schultzei* BRAUSE is a specimen with extremely narrow pinnules (4 by 18 mm); it may represent a distinct taxon.

**19. *Lindsaea longifolia*** COPELAND, Philip. J. Sc. 38 (1929) 145, pl. 3; Fern Fl. Philip. 1 (1958) 109.—Type: REILLO B. Sc. 16227, Basilan, Philippines (MICH); dupl. in B, P).—Fig. 30.

*Rhizome* short-creeping, 2 mm  $\phi$ ; scales rather dark brown, narrowly triangular, to  $1\frac{1}{4}$  mm long, to 8-seriate at base, with a short uniseriate apex. Leaves crowded; *petioles* c. 10–40 cm long,  $\frac{1}{2}$ –2 times as long as the lamina, stramineous or reddish brown or darker with age, at least in the upper part obtusely to sharply bi-angular, often also sulcate. *Lamina* bipinnate (rarely simply pinnate and fertile, or subtripinnate), 12–35 cm long, with 1–5 pinnae to a side and a conform but often longer terminal one; primary rachis abaxially bi-angular, sulcate. *Pinnae* strongly ascending,  $2\frac{1}{2}$  cm distant, linear, 10–25 by 0.7–2 cm, long-acuminate; secondary rachises abaxially bi-angular to shallowly sulcate. *Pinnules* c. 30–40 to a side, herbaceous, mostly dark green when dry, close, subcontiguous to overlapping, ascending or the lower ones spreading, 7–10 by  $3\frac{1}{2}$ –5 mm (rarely smaller, 5 by  $2\frac{1}{2}$  mm),  $1\frac{1}{2}$ – $2\frac{1}{2}$  times as long as wide, subovate to dimidiate-

subligulate, very obtuse, little narrowed to the rounded apex; upper/outer margin with 1–3 incisions, these in large pinnules  $\frac{1}{2}$ – $\frac{1}{3}$  mm deep, in small ones sometimes deeper; margin otherwise entire; sterile margin shallowly crenate. *Upper pinnules*  $\pm$  entire, gradually and very strongly reduced, several denticuliform ones confluent with the small, narrow pinna-apex. Veins immersed, not evident, mostly twice forked, forming a (sometimes incomplete) series of areoles  $\frac{1}{2}$ – $\frac{2}{3}$  mm wide. *Sori* interrupted by the incisions, mostly tri- or quadrinerval, longer in upper, entire pinnules. Indusium pale, subentire, 0.3 mm wide, not reaching the margin by 0.2 mm, little reflexed at maturity. Spores pale yellowish, trilete, smooth, c. 25  $\mu$ .

Distr. *Malesia*: Philippines (Luzon, Mindanao, Polillo, Samar, Leyte, Catanduanes, Panay, Biliran, Basilan).

Ecol. Terrestrial, in mountain forests (always?).

**20. *Lindsaea ramosii*** COPELAND, Philip. J. Sc. 38 (1929) 144, pl. 2; Fern Fl. Philip. 1 (1958) 110.—Type: RAMOS B. Sc. 7652, Cagayan Prov., Luzon (MICH).

Very similar to *L. longifolia*; pinnules small, 7 by 4 to 5 by 3 mm, more rounded, not incised.

Distr. *Malesia*: Philippines (Luzon, 4 coll.).

Note. Very doubtfully distinct from *L. longifolia*.

**21. *Lindsaea lobata*** POIRET in Lamk, Encycl. Suppl. 3 (1813) 448.—*Adiantum lobatum* (POIRET) POIRET ex STEUDEL, Nomenkl. 2 (1824) 275, *nom. invalid. in syn.*; non PRESL (1825), *nec* KUNZE ex KUHN (1881).—*Davallia lobata* (POIRET) DESVAUX, Prod. (1827) 315.—*Schizoloma lobatum* (POIRET) BEDD. Ferns S. Ind. & Br. Ind. Suppl. (1876) 6, *quoad typum*.—Type: COMMERSON s.n., Java (P).

*L. davallioides* BLUME, En. Pl. Jav. (1828) 218; HOOKER, Sp. Fil. 1 (1846) 224, pl. 68 A; DIELS in E. & P. Nat. Pfl. Fam. I, 4 (1902) 221, f. 119 G; BACKER & POSTHUMUS, Varenfl. Java (1939) 115, f. 22; not of HOLTUM, Rev. Fl. Mal. 2 (1954) 332.—*Synaphlebium davallioides* (BLUME) J. SMITH, Lond. J. Bot. 1 (1842) 424.—*Davallia kunzeana* HOOKER, Sp. Fil. 1 (1846) 177.—*Schizoloma davallioides* (BLUME) MOORE, Ind. Fil. (1857) 35.—*L. decomposita* WILLD. var. *davallioides* (BLUME) DOMIN, Bibl. Bot. 20 (1915) 84.—Type: BLUME s.n., Java (L); dupl. in P).

*L. lobata* POIRET var. *incisa* METT. ex KUHN in Miq. Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 277.—Lectotype: ZOLLINGER 1087, Java (L); dupl. in B, HBG) (the other coll. cited, ZOLLINGER II 381, is *L. obtusa*).

*Rhizome* short-creeping,  $1\frac{1}{2}$ –2 mm  $\phi$ ; scales dark reddish brown, narrowly triangular, to 2 mm long, to c. 10-seriate at base, with a short uniseriate apex. Leaves clustered; *petioles* stramineous to pale brown, quadrangular, occasionally with paler angles, abaxially flat to shallowly sulcate, at the base often dark-verruculose, 8–45 cm long, equaling to over twice as long as the

lamina. *Lamina* bipinnate (very rarely once pinnate and fertile), with 1–4, most often 2 or 3 pinnae to a side and a conform terminal one; primary rachis like the petiole, often more distinctly pale-margined, abaxially usually sulcate. *Pinnae* ascending, subsessile, linear, their width apart to contiguous, 10–20 cm long, 1.7–2.5 cm wide, widest in the lower third or the middle, gradually and strongly tapering to the often long-acuminate apex; terminal pinna often the longest and widest; secondary rachises abaxially broadly and  $\pm$  shallowly sulcate, sometimes pale-margined. *Pinnules* c. 25–40 to a side, half their width apart to contiguous, spreading or mostly ascending, herbaceous, medium to dark or blackish green when dry, translucent,  $\frac{1}{4}$ -elliptic, narrowed and obtuse to subacute, 7–15 mm long,  $2\frac{1}{2}$ –5 (often 4) mm wide,  $2\frac{1}{2}$ –3 times as long as wide, almost evenly narrowed throughout, the upper margin outward increasingly convex, with 3 or 4 major incisions, the inner ones reaching to  $\frac{1}{4}$  or  $\frac{1}{3}$ , or rarely to  $\frac{1}{2}$ , the outer ones to  $\frac{1}{2}$  or slightly beyond, with acute sinus; at least the broader lobes with convex outer margin, the lateral margins almost parallel, the major ones often shallowly incised again, otherwise entire, a distinct outer margin not developed. *Upper pinnules* strongly reduced, some denticuliform ones confluent with the narrow,  $\pm$  caudiform terminal segment. Veins immersed, evident, mostly twice forked, regularly anastomosing, with one series of areoles, one under each incision, c.  $\frac{3}{4}$  mm wide, the lobes containing 2–5 vein-ends. *Sori* joining all vein-ends of a lobe; receptacle at least in larger lobes distinctly convex; indusium pale, entire, 0.3–0.4 mm wide, reaching the margin or very nearly so,  $\pm$  reflexed at maturity; sporangia often spreading beyond the pinnule margin. Spores rather pale brown, trilete, smooth or almost so, c. 21–23  $\mu$ .

Distr. *Malesia*: Sumatra, West and Central Java, Lesser Sunda Is. (Bali, Sumba, Flores), Borneo, Celebes, Philippines (rare and local), New Guinea (rare), Admiralty Is.; a few doubtful collections from the Malay Peninsula; Caroline Is. Distinct varieties in Hainan and Indo-China. Records from elsewhere are due to confusion with related species.

Ecol. Terrestrial or on tree bases in primary forest, 50–1800, mostly 600–1500 m.

Note. In West Java, where this species is common, it is very homogeneous. Specimens from elsewhere, where it is much rarer, are often somewhat aberrant. There may be some hybridization with related species.

22. *Lindsaea parallelogramma* v.a.v.R. Bull. Jard. Bot. Btzg III, 5 (1922) 212; HOLTUM, Gard. Bull. S. S. 5 (1930) 70, f. 9; Rev. Fl. Mal. 2 (1954) 335, f. 193.—Type: BÜNNEMEIJER 7359, Mt Tjikalu, P. Singkep, Lingga Is. (BO; dupl. in L).

*L. davallioides* BLUME f. *parallelogrammoides* v.a.v.R. Nova Guinea 14 (1929) 31.—Type: H. J. LAM 859, near Prauwenbivak, W. New

Guinea (BO; dupl. in L).—Fig. 29.

*Rhizome* short-creeping,  $1\frac{1}{2}$ –2 mm  $\phi$ ; scales fawn-coloured, narrowly triangular, to 2 mm long, up to c. 10-seriate at base, with a rather short uniseriate apex. Leaves close; *petioles* characteristically olivaceous-brown, dull, sharply quadrangular, adaxially channelled and pale-margined, c. 15–30 cm long,  $1\frac{1}{2}$ –2 times as long as the lamina. *Lamina* bipinnate, broadly oblong, sometimes wider than long (rarely simply pinnate and fertile, then linear), c. 10–20 cm long, with 1–4 pairs of lateral pinnae and a conform terminal one; primary rachis similar to the petiole, abaxially channelled. *Pinnae* patent or ascending, often contiguous, sessile, c. 8–18 cm long,  $2\frac{1}{2}$ –3 cm wide, the upper ones little or not shortened; secondary rachises similar to the primary, abaxially sulcate and pale-edged. *Pinnules* c. 15–30 to a side, mostly somewhat ascending, scarcely to slightly contiguous, herbaceous, mostly drying dark brownish green, not translucent, parallelogram-shaped, the larger 9–14 mm long, 3–5 mm wide,  $2\frac{1}{2}$  to nearly 3 times as long as wide (except when the apex is caudiform), very little or not narrowed to the obliquely truncate apex. Upper and outer margin obliquely incised, the upper usually with 4, the outer with 1 incision, those of the upper margin reaching  $\frac{1}{4}$ – $\frac{1}{3}$  ( $-\frac{1}{2}$ ), the apical ones often  $\frac{1}{2}$  ( $-\frac{2}{3}$ ); lobes parallel-sided, convex, entire or minutely erose, the basal, broadest often with a shallow incision; sinus narrow, acute. Some pinnules occasionally caudate-protracted at the apex. *Upper pinnules* rather suddenly strongly reduced, several denticuliform ones confluent with the caudate, linear pinna-apex. Veins immersed or slightly raised, mostly evident, regularly anastomosing, forming a series of areoles  $\frac{1}{2}$  mm wide below the level of the incisions, rarely the larger lobes with another series. *Sori* one per lobe, up to c. 2 mm long, bi- to quadri-, mostly trinerval; indusium  $\frac{1}{5}$ – $\frac{1}{4}$  mm wide, entire, not reaching the margin by less than its width to about twice its width, reflexed at maturity. Spores very pale brown, trilete, smooth, c. 17–20  $\mu$ .

Distr. *Malesia*: Peninsular Thailand, Malay Peninsula, Singapore, Lingga Is., Banka, Sumatra, Java (very rare, no recent collections), Borneo (apparently quite common), New Guinea (a few collections from W. New Guinea and the Territory of New Guinea). Map 5.



Map 5. Distribution of *Lindsaea parallelogramma* v.a.v.R. Several localities, mainly in Borneo, could not be located.

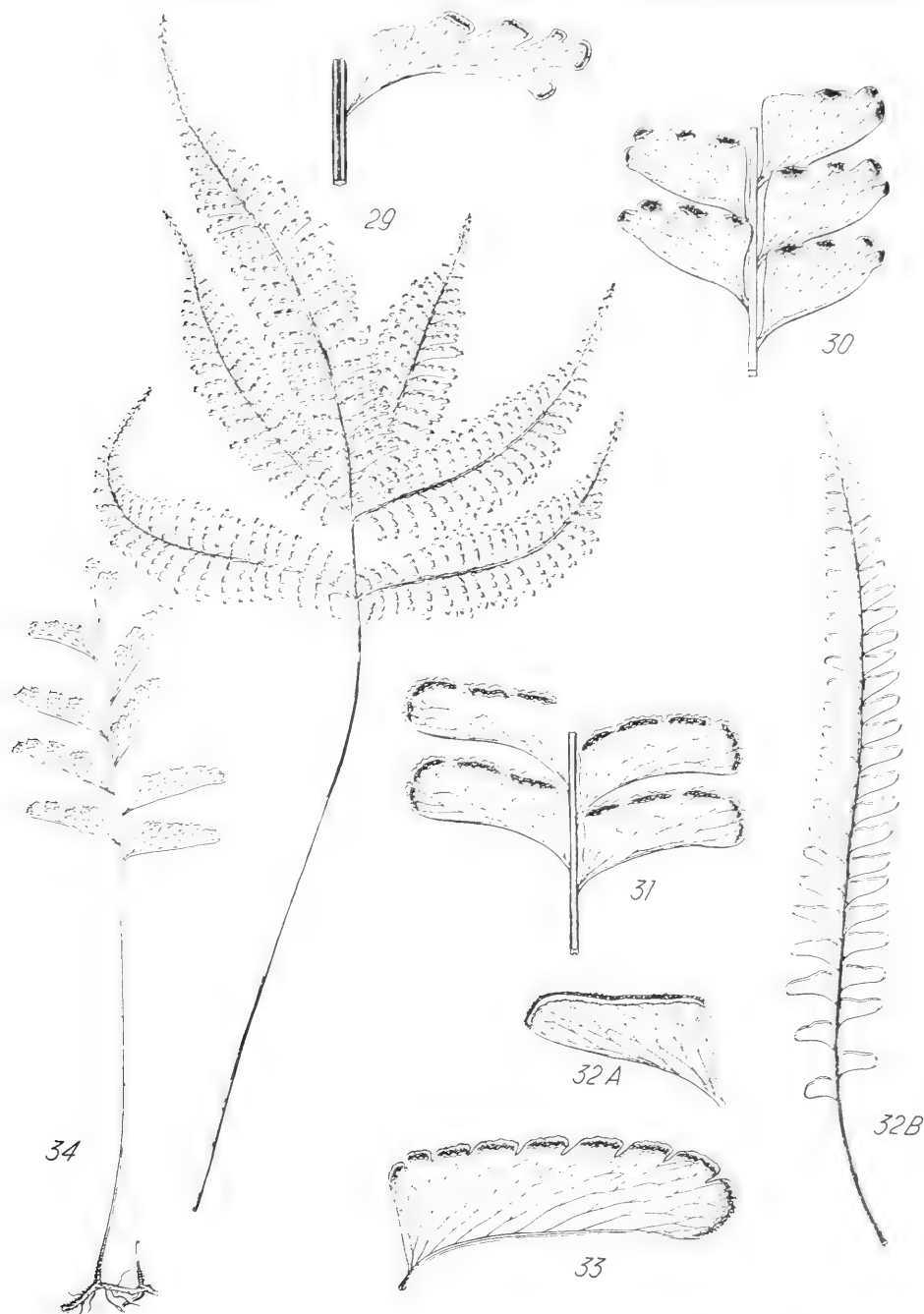


Fig. 29. *Lindsaea parallelogramma* v.A.v.R. Leaf,  $\times \frac{1}{2}$ , pinnule,  $\times 2\frac{1}{2}$  (BROOKE 9482).—Fig. 30. *L. longifolia* COPEL. Part of a pinna,  $\times 2\frac{1}{2}$  (WENZEL 585).—Fig. 31. *L. obtusa* J. SMITH in HOOKER. Part of a pinna,  $\times 2$  (BAKHUIZEN VAN DEN BRINK 6630).—Fig. 32. *L. integra* HOLTT. A. Pinnule,  $\times 2$ ; B. Leaf,  $\times \frac{1}{2}$  (WRAY 3674).—Fig. 33. *L. subalpina* v.A.v.R. Pinnule,  $\times 1\frac{1}{2}$  (BAKHUIZEN VAN DEN BRINK 3360).—Fig. 34. *L. modesta* KRAMER. Leaf, nat. size (AET & IDJAN 297).

Ecol. Terrestrial in forests, on clay soil and rocks, from sea-level up to c. 1200 m.

23. *Lindsaea cultrata* (WILLD.) SWARTZ, Syn. Fil. (1806) 119; KRAMER, Blume 15 (1968) 565; not of other authors.—*Adiantum cultratum* WILLD. Phytogr. (1794) 14, pl. 10 f. 2.—Type: coll.?, 'Malabarica' (B, herb. WILLDENOW).

*L. decomposita* WILLD. Sp. Pl. 5 (1810) 425; HOLTUM, Gard. Bull. S. S. 5 (1930) 66, f. 5; Rev. Fl. Mal. 2 (1954) 333, f. 192; COPELAND, Fern Fl. Philip. 1 (1958) 111, p.p.—Type: coll.?, 'India' (B, herb. WILLDENOW).

*L. nitens* BLUME, En. Pl. Jav. (1828) 217.—*Schizoloma nitens* (BLUME) BEDD. Ferns S. Ind. ed. 2, corr. (1873).—*Synaphlebium nitens* (BLUME) J. SMITH, Hist. Fil. (1875) 268.—Type: BLUME s.n., Java (L).

*Synaphlebium recurvatum* HOOKER in Hooker & Bauer, Gen. Fil. (1842) pl. 101; J. SMITH, Hist. Fil. (1875) 268, pl. 18 c.—*L. recurvata* (HOOKER) HOOKER, Sp. Fil. 1 (1846) 220, pl. 70 A; HOLTUM, Gard. Bull. S. S. 5 (1930) 66.—*Schizoloma recurvatum* (HOOKER) MOORE, Ind. Fil. (1857) 35.—Type: a plant without data, prob. coll. by WALLICH, must be the type (K).

*L. intermedia* HOOKER, Sp. Fil. 1 (1846) 222, pl. 67 B.—Type: CUMING 404 [err. (?) cited as '464'] 'Philippines', more probably Malay Peninsula (K; dupl. in BM).

*L. intermedia* HOOKER var. *minor* HOOKER, Sp. Fil. 1 (1846) 222, nom. *subnud.*—Type: CUMING 392, Malacca (K; dupl. in B, BM, E, GH, L, SING, W).

*L. sarasinorum* CHRIST, Verh. Naturf. Ges. Basel 11 (1897) 429; Ann. Jard. Bot. Btzg 15 (1897) 101, pl. 14 f. 13 (poor). —Type: SARASIN s.n., Ussu, Celebes (P).

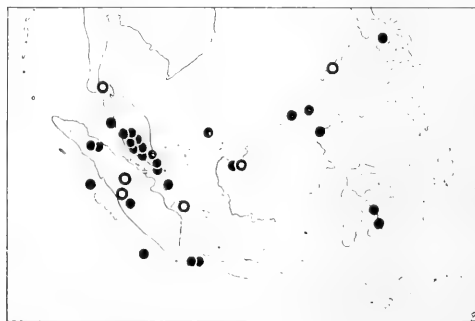
*L. nitida* COPELAND, Philip. J. Sc. 6 (1911) Bot. 138, pl. 21; not of HOLTUM, Rev. Fl. Mal. 2 (1954) 333. —Type: BROOKS 12, Mt Penrissen, Sarawak (MICH).

*L. trapezoidea* COPELAND, Un. Cal. Publ. Bot. 14 (1929) 376, pl. 61.—Type: BARTLETT 7029, near Aek Kanopan, Kualu, Sumatra (UC, n.v.; dupl. in MICH, US).

*Rhizome* short-creeping,  $1\frac{1}{2}$ –2 mm  $\sigma$ ; scales reddish brown, narrowly triangular, to  $1\frac{1}{2}$  mm long, to 8-seriate at base, with a short uniseriate apex. Leaves close; *petioles* stramineous, abaxially at least in the upper part obtusely or usually acutely bi-angular and often sulcate, 10–40 cm long,  $\frac{1}{2}$ – $1\frac{1}{2}$  times as long as the lamina. *Lamina* simply pinnate or in full-grown plants (probably always) bipinnate, with 1–2 pinnae to a side and a conform but sometimes larger terminal one, 10–30 cm long; primary rachis of bipinnate leaves like the upper part of the petiole. *Pinnae* obliquely patent, narrowly oblong, like simply pinnate laminas, 10–20 cm long, 2–4 cm wide, acute or shortly, rarely more long-acuminate; pinnule-bearing rachises abaxially sharply bi-angular or shallowly sulcate, the edges sometimes slightly wing-like. *Pinnules* c. 12–30 to a side, less than their width apart to contiguous, spreading to

somewhat ascending or, especially in smaller, simply pinnate laminas the basal ones decurved, herbaceous, medium to dark green when dry, trapeziform to rhombic, or in larger leaves often ligulate or truncate-ligulate, not very rarely with a slightly protracted apex, the larger ones 12 by 3 to 19 by 7 mm, almost  $2\frac{1}{2}$  to 3 times as long as wide, usually little narrowed; upper margin straight or convex outward, a separate outer margin present, joining the upper at right angles or more often at an acute angle, less often rounded into the upper margin; upper margin of larger fertile pinnules with 1–3 narrow oblique incisions to 1 mm deep, the outer margin occasionally with one incision; smaller pinnules often entire; sterile margin shallowly crenate; fertile margin not erose; lobes flat. A few *upper pinnules* strongly reduced, or less often many, 1 or 2 or a few connected with the narrow, acute, asymmetrically lanceolate terminal segment. Veins immersed, evident or not, regularly anastomosing, forming one (very rarely parts of a second) series of areoles, the larger ones  $\frac{3}{4}$ – $1\frac{1}{4}$  mm wide. *Sori* interrupted by the incisions, the sorus on the outer margin mostly continuous with the outermost one of the upper. Indusium pale or greenish, entire or almost so, 0.2–0.3 mm wide, not reaching the margin by an equal distance or usually less, little reflexed and scarcely concealed at maturity. Spores pale brown, trilete, smooth, c. 20  $\mu$ .

Distr. S. India?, Ceylon, Botel Tobago, S. Thailand; in *Malesia*: Malay Peninsula, Singapore, Riouw Is., S. China Sea Is., Sumatra, Mentawai Is., Banka, West Java, Borneo, Celebes (a few collections), Philippines (Palawan, Sibuyan). In the Solomon Is. an aberrant, perhaps distinct form. Map 6.



Map 6. Distribution of *Lindsaea cultrata* (WILLD.) Sw. in Malesia; further known from Ceylon, S. India, and the Solomons (a distinct? form).

Ecol. Terrestrial in forests, up to c. 1300 m; often locally frequent.

Note. The name *L. decomposita*, under which this species was known for a long time, has been greatly misused for various species of *sect. Syna-*



*phlebium*. The combination of little reduced upper pinnules, sori interrupted by shallow incisions of the margin, and the sorus on the outer margin continuous with the outermost one on the upper, is distinctive, but it is not rare to find plants which otherwise agree with *L. cultrata* but in which one or the other of these characters is missing.

**24. *Lindsaea papuana*** COPELAND, Philip. J. Sc. 7 (1912) Bot. 68; *ibid.* 78 (1949) 21.—Type: KING 358, Lakekamu, Papua (MICH).

*Rhizome* short-creeping, c.  $1\frac{1}{4}$  mm  $\phi$ ; scales very narrowly triangular to acicular, to 3 mm long, to 7-seriate at base but often the apical half uniseriate, the basal half biseriate almost to base. Leaves close; *petioles* stramineous, abaxially below obtusely, upward acutely bi-angular and sulcate, c. 12–30 cm long,  $1\frac{1}{2}$  times as long as the lamina. *Lamina* 15–22 cm long, simply pinnate or with one pair of pinnae to 15 cm long and a conform terminal one; rachises like the upper part of the petiole. *Pinnules* c. 20–30 to a side, dark olivaceous when dry, herbaceous, spreading, the upper ones subcontiguous, the lower ones their width apart; larger pinnules asymmetrically elongate-triangular to subligulate, 18 by 6 to 30 by 9 mm,  $3\frac{1}{2}$  times as long as wide, not much narrowed to the narrowed-rounded apex, a distinct outer margin not developed; both margins almost straight at base and convex outward. *Upper pinnules* gradually and strongly reduced, 1 or 2 of a few mm long connected with the narrowly lanceolate acuminate terminal segment. *Margins* entire, or the upper remotely and shallowly crenate; sterile margin not seen. Veins immersed,  $\pm$  evident, regularly anastomosing, with 1 or not rarely 2 rows of areoles of fluctuating width. *Sori* continuous, or interrupted by the crenations of the upper margin (probably quite continuous in fully fertile pinnules). Indusium entire, greenish,  $\frac{1}{4}$  mm wide or less, not reaching the margin by its width or more, scarcely reflexed at maturity. Spores light brown, trilete, smooth, c. 23  $\mu$ .

Distr. Only known from the type collection.

Ecol. No data.

Note. In habit this species rather closely resembles certain forms of the neotropical *L. arcuata* KUNZE.

**25. *Lindsaea integra*** HOLTUM, Gard. Bull. S. S. 5 (1930) 67, f. 6.—*L. nitida* auct. non COPELAND; HOLTUM, Rev. Fl. Mal. 2 (1954) 333, f. 191.—Type: HOLTUM 20934, Tahan R., Pahang (SING; dupl. in BM, BO, K, US).—Fig. 32.

*Rhizome* short-creeping,  $1\frac{1}{2}$ –2 mm  $\phi$ ; scales medium brown, narrowly to very narrowly triangular, to  $\frac{1}{4}$  mm long, to 6-seriate at base, with a long uniseriate apex. Leaves clustered; *petioles* sharply quadrangular almost throughout, reddish, abaxially in the upper part mostly pale and somewhat wing-angled, rarely stramineous, 2–20 cm long, much shorter than to about equaling the lamina. *Lamina* linear, 8–22 cm

long,  $1\frac{1}{2}$ –2 cm wide (wider if bipinnate), simply pinnate, or rarely with one pair of pinnae; rachis similar to the upper part of the petiole, abaxially nearly always distinctly wing-angled. *Pinnules* c. 6–30 to a side, ascending or the lower ones spreading, their width apart to contiguous, chartaceous, mostly olivaceous when dry, subtrapezoidal to semi-ovate, the larger ones 7–12 (–15) by  $3\frac{1}{2}$ –6 (–7) mm, twice as long as wide, rounded or subtruncate at apex, narrowed from the base to the rounded apex, or, especially if subtruncate, little narrowed, the outer margin often meeting the upper at an angle of less than  $90^\circ$ . *Lower pinnules* sometimes slightly remote; a few (more in larger leaves) *upper pinnules* rather suddenly but not strongly reduced, rarely less than half as long as the larger ones, the terminal segment narrowly rhombic to lanceolate, c.  $\frac{1}{2}$ –1 cm long, free or almost so. Veins immersed, little evident, not very regularly anastomosing, with one (very rarely two) series of areoles, the outer veins often (in small pinnules sometimes all veins) free; areoles  $\frac{1}{2}$ – $\frac{3}{4}$  mm wide. *Sori* continuous, uniting all vein-ends; indusium subentire, brownish, 0.3–0.4 mm wide, almost or quite reaching the margin, reflexed at maturity. Spores pale yellowish, trilete smooth, c. 22  $\mu$ .

Distr. S. Peninsular Thailand; *Malesia*: Malay Peninsula (Pahang, Perak, Malacca, Selangor), Sumatra (1 coll.), Borneo (Sabah, Sarawak, Brunei).

Ecol. Terrestrial in forest, often (always?) by streams on rocks; from c. 100–1200 m; few ecological data. Reported to be a rheophyte by ASHTON, Sarawak.

**26. *Lindsaea azurea*** CHRIST, Verh. Naturf. Ges. Basel 11 (1897) 429; Ann. Jard. Bot. Btzig 15 (1897) 101, pl. 14 f. 12; COPELAND, Philip. J. Sc. 78 (1949) 21.—Type: SARASIN s.n., Ussu, Celebes (P).

*L. azurea* CHRIST var. *mambae* v.A.v.R. Bull. Jard. Bot. Btzig II, 7 (1912) 21.—Type: KING 48 'p.p.', Mamba, Papua (BO).

*Rhizome* short-creeping, 2–3 mm  $\phi$ ; scales reddish brown, narrowly triangular, to 2 mm long, to c. 8-seriate at base, with a short uniseriate apex. Leaves close; *petioles* stramineous to pale brown, or darker with age, abaxially subterete, upwards obtusely or less often acutely bi-angular, 20–35 cm long, about equaling the lamina. *Lamina* oblong, c. 15–35 cm long, with 2–4 pinnae to a side and a conform terminal one (rarely simply pinnate but fertile); primary rachis similar to the upper part of the petiole, rarely shallowly sulcate. *Pinnae* obliquely ascending, sessile, 12–25 cm long,  $1\frac{1}{2}$ –2 $\frac{1}{2}$  cm wide, widest in the lower third or in the middle, gradually and strongly tapering at the tip. Secondary rachises abaxially terete at the base, upward gradually bi-angular, or bi-angular almost to the base, usually little sulcate. *Pinnules* c. 25–40 to a side, spreading or little ascending, mostly subcontiguous, rounded-trapeziform, the larger ones 9–15 by 4–7 mm, about twice as long as wide; apex rounded, but

the outer margin distinct, especially from the lower, forming an angle of about 90° with the slightly convex upper margin. Margins entire, or shallowly crenate if sterile; texture firmly herbaceous, dark green and  $\pm$  glossy above when dry, sometimes described as bluish in the living state. *Upper pinnules* strongly reduced, several denticuliform ones connected with the small, narrow terminal segment. Veins immersed, evident, not very oblique, regularly anastomosing, with one, occasionally part of a second series of areoles; larger areoles  $\frac{1}{2}$ –1 mm wide. *Sori* in completely fertile pinnules continuous on upper and outer margin; indusium entire,  $\frac{1}{8}$ – $\frac{1}{4}$  mm wide, not reaching the margin by an equal or slightly larger distance, reflexed at maturity. Spores medium brown, trilete, smooth, *c.* 22  $\mu$ .

Distr. *Malesia*: New Guinea; a few collections from Celebes and Borneo.

Ecol. Terrestrial in rain-forests, 80–1500 m.

Note. In habit this species is rather like the South American *L. guianensis* (AUBL.) DRYAND. *ssp. lanceastrum* KRAMER.

27. *Lindsaea crispa* BAKER, J. Bot. n.s. 8 (1879) 39; HOOKER, Ic. Pl. 17 (1886) pl. 1627; C. CHR. & HOLTUM, Gard. Bull. S. S. 7 (1934) 238.—Type: BURBIDGE *s.n.*, Sabah (K).

*L. impressa* CHRIST, Ann. Jard. Bot. Btzig II, 5 (1905) 132.—Type: HALLIER 3137, Amai Ambit, Kalimantan, Borneo (L; fragm. in BO, P).

*L. kinabaluensis* HOLTUM, Gard. Bull. S. S. 7 (1934) 237.—Type: CLEMENS 25433, Tenompok to Lumulumu, Mt Kinabalu, Sabah (SING; dupl. in BM).

*Rhizome* short-creeping, 1–1½ mm  $\phi$ ; scales medium brown, elongate-triangular, to *c.* 1¼ mm long, to *c.* 10-seriate at base, with a short uniseriate apex. Leaves clustered; *petioles* medium to dark brown (rarely pale), in large leaves longer than the lamina and abaxially mostly obtusely bi-angular, in small leaves shorter than the lamina and abaxially sharply bi-angular, pale-edged or not, 6–45 cm long. *Lamina* simply pinnate or bipinnate (very rarely subtripinnate), if bipinnate with up to 3 pinnae to a side and a conform terminal one, *c.* 15–20 cm long, if once pinnate, *c.* 8–15 by 1½–2 cm. Primary rachis (if any) like the petiole. *Pinnae* 10 by 1½ to 18 by 3 cm; pinnule-bearing rachises stramineous to dark brown, abaxially sharply bi-angular, pale-edged or not,  $\pm$  sulcate. *Pinnules* *c.* 25–30 to a side, spreading, ascending, or falcately decurved, their width apart to slightly overlapping, ¼-elliptic to falciform, 5 by 2 to 15 by 5 mm, 2½–3 times as long as wide, dark green to blackish when dry, chartaceous; apex of pinnules narrowed-rounded to very obtuse, a distinct outer margin not developed. *Upper pinnules* gradually and strongly reduced, several denticuliform ones confluent into a narrow pinnatifid leaf- or pinna-apex. Veins slightly impressed on the adaxial and prominent on the abaxial side, once or twice forked, anastomosing to form an incomplete series of areoles  $\frac{1}{2}$ –1 mm wide, the outer veins

often free, in small (rarely in larger ones) pinnules the veins may be quite free. Sterile margin sinuate-dentate, fertile margin mostly crispate. *Sori* continuous in fully fertile pinnules; indusium delicate, pale, subentire, sometimes crispate, 0.3–0.5 mm wide, not reaching the margin by ½–1 times its width, reflexed and often concealed at maturity. the fertile margin sometimes revolute over part of the sorus. Spores pale brown, trilete, smooth, 20–22  $\mu$ .

Distr. *Malesia*: Borneo (Kalimantan, Sarawak, more frequent on Mt Kinabalu, Sabah).

Ecol. Terrestrial in forests, *c.* 1000–1600 m.

Note. The series of plants assigned to this species is rather variable. If it were not for the limited geographical distribution they might be taken for depauperate specimens of one or several other species.

28. *Lindsaea hewittii* COPELAND, Philip. J. Sc. 3 (1909) Bot. 346, pl. 5.—Type: HEWITT 36, Mt Poi, Sarawak (MICH; dupl. in BM, P, SAR).

*Rhizome* short-creeping, 1–2 mm  $\phi$ ; scales castaneous, narrowly triangular, to *c.* 1 mm long, to *c.* 7-seriate at the base, with a short uniseriate apex. Leaves close; *petioles* rather dark brown, faintly pale-margined, the greater part acutely, the base obtusely quadrangular, abaxially  $\pm$  sulcate, *c.* 22–30 cm long, twice as long as the lamina. *Lamina* approximately rhombic in outline, 12–15 cm long, bipinnate, with 2 or 3 ascending pinnae to a side and a conform terminal one; rachis like the petiole, pale to medium brown. *Pinnae* linear, 9–12 cm long, 1–1¼ cm wide, widest above the base, long-acuminate, with *c.* 25–35 pinnules to a side; secondary rachises reddish brown, abaxially sharply bi-angular, stramineous-margined, hardly sulcate. *Pinnules* slightly ascending, not contiguous, chartaceous, olivaceous when dry, ligulate or more often ¼-elliptic, the larger ones 5 by 2½ mm, twice as long as broad; upper margin with 1 or 2 oblique incisions ½ mm deep or less; lobes with a slightly convex or the inner ones with a straight outer margin. *Upper pinnules* gradually and very strongly reduced, several minute, denticuliform ones confluent with the linear, very narrow pinna-apex. Veins immersed,  $\pm$  evident, very close, regularly anastomosing, forming one series of areoles *c.* ½ mm wide. *Sori* interrupted by the incisions on the outer, sometimes also on the inner lobes (the material probably incompletely fertile), 2- to 8-nerval; indusium brownish, subentire, 0.3–0.4 mm wide, not reaching the margin by an approximately equal distance, scarcely reflexed at maturity. Spores yellowish brown, trilete, smooth, *c.* 20  $\mu$ .

Distr. Beside the type known from two other collections from the same area.

Ecol. No data.

Note. This is perhaps only an extreme form of the very variable *L. obtusa*.

29. *Lindsaea obscura* BRAUSE, Bot. Jahrb. 56 (1920) 132; COPELAND, Philip. J. Sc. 78 (1949)

20.—Type: LEDERMANN 8969, Etappenberg, Sepik R. region, Terr. of New Guinea (B).

*Rhizome* rather short-creeping, 1 mm  $\sigma$ ; scales not seen. Leaves close; *petioles* quadrangular, sulcate, blackish, narrowly pale-margined, c. 5 cm long, almost as long as the lamina. *Lamina* simply pinnate, c. 5–7½ cm long; rachis similar to the petiole. *Pinnules* c. 4–8 to a side, almost contiguous at their bases, spreading, subtrapeziform to ¼-elliptic-subligulate, 1–2 cm long, 5–8 mm wide, 2–2½ times as long as wide, dark green when dry, herbaceous; upper margin outward increasingly convex, a distinct outer margin hardly or not developed. Margin of smaller pinnules entire, in larger ones the upper/outer margin with 1–3 oblique rather broad incisions to 1 mm deep. *Upper pinnules* very little reduced; terminal pinnule free, large, flabellate with cuneate base, almost symmetric, with convex upper margin, incised like the lateral ones, c. 1 cm long and 1½ cm wide. Veins immersed, not evident, mostly twice forked, regularly anastomosing, with one or towards the apex of the pinnules two series of areoles 1–1¼ mm wide. *Sori* interrupted by the incisions of the margin, if any, also on the outer margin of the terminal pinnule, 4- to plurinerval; indusium greenish, subentire, ¼ mm wide, falling short of the margin by ½–1 times its width. Spores very pale brown, trilete, smooth, c. 20  $\mu$ .

Distr. Beside the type only known from another collection from the same area (LEDERMANN 9163a, B).

Ecol. Epiphytic in mountain forest, 850 m.

30. *Lindsaea modesta* KRAMER, Blumea 15 (1968)

#### 4. Section *Lindsaea*

Type species: *Lindsaea trapeziformis* DRYAND. [= *L. lancea* (L.) BEDD.].

Distr. Tropical America, SE. Asia.

Taxon. The two paleotropical species share with the neotropical ones a short-creeping rhizome, a bipinnate lamina with conform terminal pinna, or a simply pinnate lamina, dimidiate pinnules, free veins, and continuous sori. The spores are trilete in most neotropical and both paleotropical species. Otherwise the resemblance is not close, in spite of much habitual similarity between *L. borneensis* HOOKER and *L. guianensis* (AUBL.) DRYAND., and between *L. doryphora* KRAMER and *L. lancea* (L.) BEDD. It is not at all certain that the paleotropical species are of the same derivation as the neotropical ones.

31. *Lindsaea borneensis* HOOKER ex BAKER, Syn. Fil. ed. 1 (1867) 107; HOLTUM, Gard. Bull. S. S. 5 (1930) 65; Rev. Fl. Mal. 2 (1954) 331.—Lectotype: LOBB 175, Labuan I., Borneo (K).

*Rhizome* short- to long-creeping, 2–4 mm  $\sigma$ ; scales castaneous, narrowly triangular, to 2½ mm long, to c. 8-seriate at base, with acicular, uniseriate apex. Leaves close; *petioles* stramineous, abaxially terete, to 60 cm long, to 2 times as long as the lamina. *Lamina* oblong, to c. 40 by 25 cm, bipinnate, with up to 12 pinnae to a side and a conform terminal one; primary rachis like the petiole. *Pinnae* mostly subopposite, about their width apart, linear, long-acuminate, spreading

565.—Type: AET & IDJAN 297, Waimiami near Serui, Japen I. (BO).—Fig. 34.

*Rhizome* rather long-creeping, wiry, 0.4 mm  $\sigma$ , fuscous, dull; scales rather persistent, dark brown, scarcely 1 mm long, acicular, biseriate in the lower, uniseriate in the upper half. *Petioles* ½–¾ cm apart, to 7 cm long, a little longer than the lamina, stramineous and quadrangular almost to the base, slender, ¼–½ mm  $\sigma$  at the apex. *Lamina* c. 4–6 cm long, 3 cm wide, oblong, simply pinnate, with 4–5 pinnules to a side; rachis like the petiole. *Pinnules* thinly herbaceous, olivaceous when dry, translucent, somewhat ascending, their width or a little less apart, obliquely triangular, the base rather strongly cuneate, somewhat stalk-like, the apex subacute, the largest 15 by 4–5 mm, almost evenly narrowed from base to apex; upper margin with mostly 3 very oblique major incisions to 1 mm deep, the lobes with slightly to strongly and irregularly erose outer edge. *Upper pinnules* little reduced. Terminal pinnule free, flabellate-cuneate, 1–2 cm long, usually once deeply and once or twice shallowly bifid. Veins immersed, evident, very oblique, once or twice forked, forming one series of areoles, the outer veins not rarely free. *Sori* mostly bi- or trinerval, in the larger lobes often interrupted by the gashes in the margin, basally straight or with slightly concave ends; indusium 0.3–0.4 mm wide, subentire or usually erose, not reaching the margin by less than its width to reaching it,  $\pm$  reflexed at maturity. Spores pale brownish, trilete, smooth, c. 20  $\mu$ .

Distr. Only known from the type collection.

Ecol. No data on the label, but probably epiphytic, as the rhizomes are rather long and interwoven with mosses and *Hymenophyllaceae*.

or ascending, 8–25 cm long, 1¼–2 cm wide, the upper ones little or not shortened, the terminal often the longest; secondary rachises abaxially terete at base, upward gradually bi-angular, sulcate only in the upper part. *Pinnules* to c. 50 to a side, dark green when dry, firmly herbaceous, spreading, mostly slightly overlapping, ¼-elliptic or shortly ligulate, 7 to 11 mm long, 3½–5 mm wide; margin crenate if sterile, otherwise entire. *Upper pinnules* gradually and strongly reduced, denticuliform below the pinnatifid, sometimes caudate pinna-apex. Veins immersed or more often slightly prominulous, mostly twice forked, close, free. *Sori* in fully fertile pinnules occupying all vein-ends but often only on the inner ones, con-

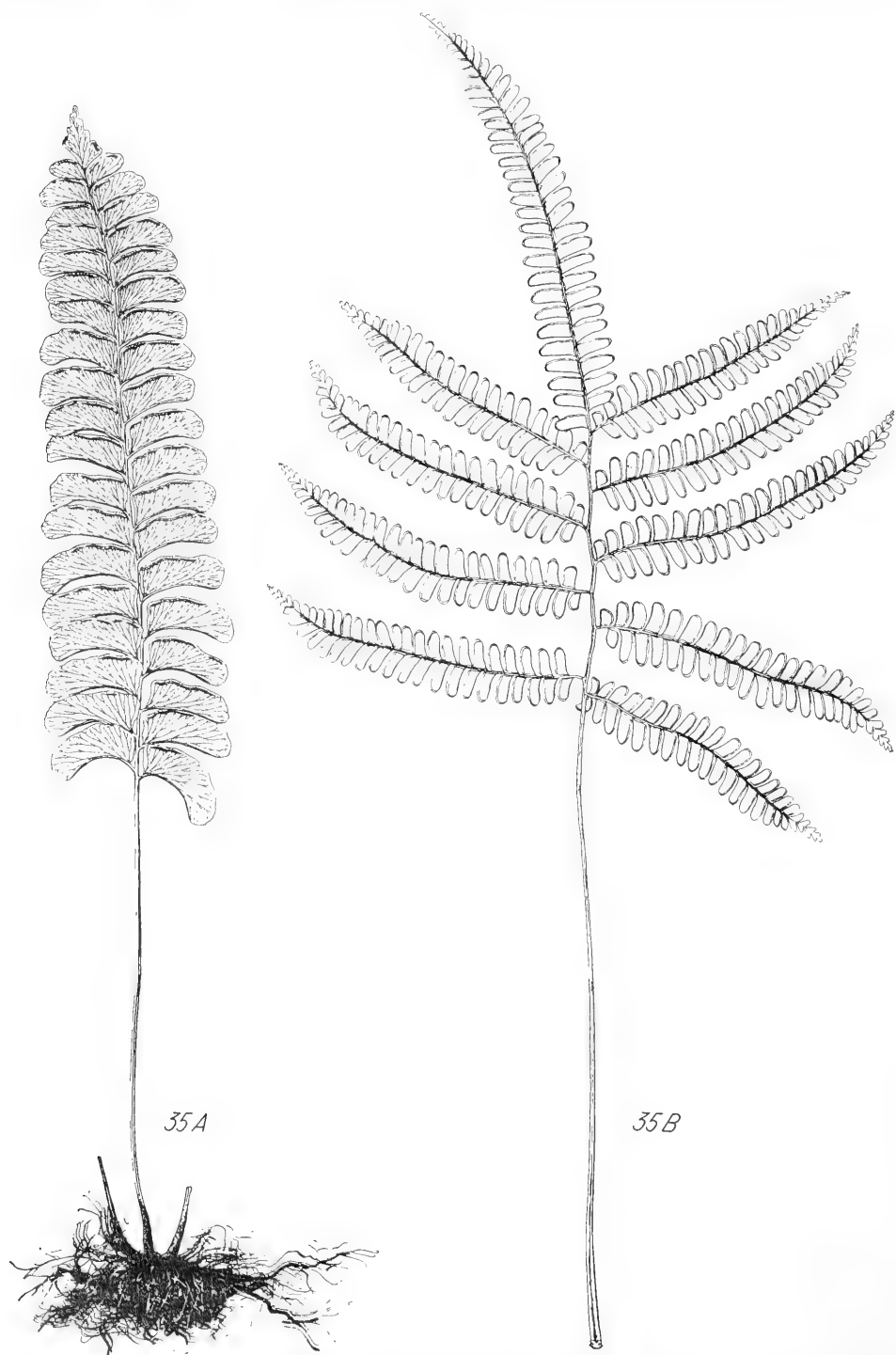


Fig. 35. *Lindsaea doryphora* KRAMER. A. Simply pinnate lamina,  $\times \frac{2}{6}$  (KORTHALS 298); B. Bipinnate lamina,  $\times \frac{1}{4}$  (KORTHALS 296).

tinuous; indusium brownish, entire, c.  $\frac{1}{5}$ – $\frac{1}{4}$  mm wide, falling short of the margin by its own width or less, reflexed and concealed at maturity. Spores pale brown, trilete, smooth, c. 22  $\mu$ .

Distr. *Malesia*: Malay Peninsula (Selangor, Johore, Perak), Singapore (according to HOLTUM perhaps extinct), Sumatra (few coll.), Borneo (apparently frequent throughout).

Ecol. In forests, on shaded rocks, mostly on poor, moist soil, to c. 700 m.

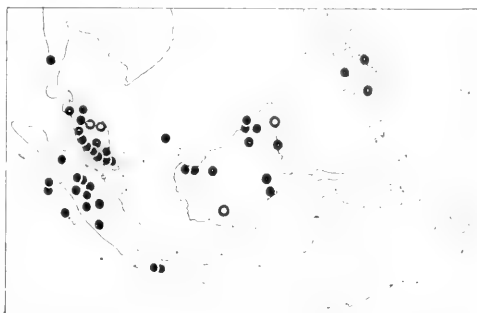
Note. In appearance rather like the neotropical *L. guianensis* (AUBL.) DRYAND. *ssp. guianensis*, and perhaps related to it.

**32. *Lindsaea doryphora* KRAMER**, *Blumea* 15 (1968) 566.—*L. scandens* HOOKER var. *terrestris* HOLTUM, Rev. Fl. Mal. 2 (1954) 327, *nom. invalid.* (not typified).—*L. lancea* or *L. trapeziformis* auct. *quoad specimina asiatica*.—Type: ALSTON 13358, Permantang, S. of Kwala Kwajan, Kalimantan, Borneo (U; dupl. in BM).—Fig. 35.

*Rhizome* rather short-creeping,  $1\frac{1}{2}$ –2 mm  $\phi$ ; scales medium brown, very narrowly triangular, to  $1\frac{1}{2}$  mm long, to c. 12-seriate at base, with a short uniseriate apex. Leaves close; *petioles* stramineous, abaxially rounded or rarely upward obtusely biangular, to 70 cm long, 1–2 times as long as the lamina. *Lamina* 15–35 cm long, bipinnate or (only when not yet full-grown?) simply pinnate, with 1–6 pinnae to a side and a conform terminal one; primary rachis similar to the petiole. *Pinnulae* (and simply pinnate lamina) to 25 cm long,  $2\frac{1}{2}$ –5(–7) cm wide, ascending, half their width apart to contiguous, widest below or in the middle or sometimes scarcely narrowed close to the apex; secondary rachises similar to the primary. *Pinnules* usually 20–25 to a side, subcontiguous, chartaceous, dark green when dry, described by many collectors as having a metallic sheen, somewhat variable in shape, if large ligular, spreading or slightly decurved, not rarely with concave lower margin,  $2\frac{1}{2}$ –3 times as long as wide; if smaller similar or rounded-trapeziform, 2– $2\frac{1}{2}$  times as long as wide; largest pinnules seen 35 by 13 mm, but more often about 15–20 by 6–8 mm. Upper margin outward increasingly convex, a distinct outer margin hardly developed. Sterile margin shallowly crenate towards the apex of the pinnule. *Upper pinnules* in simply pinnate and paucijugate-bipinnate leaves mostly little reduced, few or none denticuliform and confluent with the comparatively large, obliquely hastate, obtuse to acuminate terminal pinnule; in larger, more amply bipinnate leaves not rarely the upper pinnules more strongly reduced, several confluent with the small, basally lobed, lanceolate terminal

segment. Veins immersed, evident, rather close, free, mostly twice forked. *Sori* occupying all vein-ends of a pinnule or not rarely only the inner ones, continuous; indusium pale to dark, entire,  $\frac{1}{4}$ – $\frac{1}{5}$  mm wide, falling short of the margin by 1–2 times its width,  $\pm$  reflexed at maturity. Spores pale brownish, trilete, smooth, c. 17  $\mu$ .

Distr. Tenasserim, S. Thailand, in *Malesia*: Malay Peninsula, Singapore, Sumatra, Sipora, Natuna Is., Lingga Is., West Java (rare), Borneo, Philippines (Negros, Leyte, Mindanao). Map 7.



Map 7. Distribution of *Lindsaea doryphora* KRAMER.

Ecol. Terrestrial in moist to swampy forests, from sea-level to 1300 m, apparently frequent in large parts of its area.

Note. This species was described by HOLTUM as a variety of *L. scandens* (= *L. parasitica*); in the present treatment the two species are placed in different subgenera. Yet the similarity between them is striking, and detached leaves, without the rhizome, are sometimes difficult to determine as the one or the other. The following additional characters may help in determining such incomplete specimens:

*L. doryphora*: lamina of simply pinnate leaves hardly or not narrowed at base; sterile pinnule-margin crenate, especially near the apex; groove of rachis (adaxial) narrow, quite concave; indusium falling short of the margin by its width or more; colour of dry pinnules dark green or oliveaceous.

*L. parasitica*: lamina of simply pinnate leaves gradually narrowed to base; sterile pinnule-margin entire or faintly sinuate; groove of rachis (adaxial) broad, flat- or convex-bottomed; indusium falling short of the margin by its width or less; colour of dry pinnules often blackish.

## 5. Section *Osmolindsaea*

KRAMER, *Blumea* 15 (1968) 560.

Type species: *Lindsaea odorata* ROXB. [*L. cultrata* auct. non (WILLD.) SWARTZ].

Distr. Rhodesia, Madagascar; N. India and China to Japan, *Malesia* and the Solomon Is.

Taxon. Well-marked by a short-creeping rhizome, simply pinnate lamina with abaxially rounded axes and reduced upper pinnules, dimidiate free-veined pinnules with (except in reduced forms) broken

sori, and monoete spores; the last character is not found in any other Malesian section. A group of rather obscure affinity, perhaps related to the next.

33. *Lindsaea odorata* ROXB. Calc. J. Nat. Hist. 4 (1844) 511; KRAMER, *Blumea* 15 (1968) 567.—Type: a plant from the Garrow Hills, India; no specimen extant; pl. 2578 of *Icones Roxburghianae* to be regarded as type (K).

*L. apiculata* KUNZE, *Farrnkr.* 1 (1846) 206, pl. 4 A.—Type: SONDER 16, Java (*n.v.*).

*L. cultrata* (WILLD.) SWARTZ var. *attenuata* HOOKER, *Sp. Fil.* 1 (1846) 204.—Lectotype: GRIFFITH *s.n.*, Khasia, Assam (K).

*L. cultrata* (WILLD.) SWARTZ var. *pallens* HOOKER, *l.c.*—Type: WALLICH *s.n.*, Nepal (K).

*L. calomelanos* KUNZE, *Bot. Zeit.* 6 (1848) 214.—Type: ZOLLINGER 1892, Java (dupl. in B, HBG, L, Z).

*L. loheriana* CHRIST, *Bull. Herb. Boiss.* I, 6 (1898) 44, pl. 4 f. 6.—Type: LOHER *s.n.*, Atoc, Luzon (P).

*L. cultrata* (WILLD.) SWARTZ var. *varia* COPELAND in PERKINS, *Fragm. Fl. Philip.* (1905) 181; *Fern Fl. Philip.* 1 (1958) 108.—Type: ELMER 6003, Bagoio, Luzon (MICH; dupl. in B, BO, US).

*L. crassipes* ROSENSTOCK in Fedde, *Rep.* 5 (1908) 36; COPELAND, *Philip. J. Sc.* 78 (1949) 19.—Type: WERNER 74, Upper Mojo R., Terr. of New Guinea (B; dupl. in L, US).

*L. bullata* v.A.v.R. *Bull. Jard. Bot. Btzg* II, 16 (1914) 20.—Type: DOCTERS VAN LEEUWEN 1104, Mt Telemojo, Java (BO; dupl. in L.)

*L. plumula* RIDL. *J. Mal. Br. R. As. Soc.* 4 (1926) 22; HOLTUM, *Gard. Bull. S. S.* 5 (1930) 62, f. 1–2.—*L. cultrata* (WILLD.) SWARTZ var. *plumula* (RIDL.) HOLTUM, *Rev. Fl. Mal.* 2 (1954) 329.—Type: RIDLEY 15997, G. Tahan, Pahang (SING; dupl. in BM, K).

*L. cultrata* (WILLD.) SWARTZ var. *parvula* HOLTUM, *Gard. Bull. S. S.* 5 (1930) 61, f. 3.—Type: Md. NUR 7297, Sibolangit, Sumatra (SING; dupl. in K).

*L. cultrata auct. non* (WILLD.) SWARTZ of all later authors, e.g. TAGAWA, *Act. Phytotax. Geobot.* 6 (1937) 26, f. 1 A–C; BACKER & POSTHUMUS, *Varenfl. Java* (1939) 118, f. 23; HOLTUM, *Rev. Fl. Mal.* 2 (1954) 328, f. 188; COPELAND, *Fern Fl. Philip.* 1 (1958) 107.

*Rhizome* short-creeping, dark, 1½–2½ mm ø, occasionally more slender and long-creeping in epilithic specimens; scales reddish brown, very narrow, to 2½ mm long, to 4-seriate at base, ¼–½ uniseriate. Leaves close (or occasionally more remote); *petioles* (3–)6–25 cm long, 1/3–2/3, rarely as long as the lamina, stramineous with darker base or more often pale reddish brown to atropurpureous throughout, hardly lustrous, abaxially rounded or upward narrowed-rounded, the adaxial groove often pale-edged. *Lamina* narrowly oblong or narrowly lanceolate, 8–30 cm long, 2–4½ cm wide, simply pinnate, with 15–30 (rarely fewer) pinnules to a side, these subpetiolulate, alternate except the basal ones, spreading or slightly ascending, less than their width apart to contiguous, in the lower 1/3 or 1/2 more remote,

the basal ones usually remote and slightly or occasionally more strongly reduced and sometimes decurved. *Rachis* abaxially rounded or narrowed-rounded, stramineous or dark at base (rarely throughout), the pinnule-bases abruptly pale. *Larger pinnules* 8–21 mm long, 3–8 mm wide, 2½, rarely 3 times as long as wide, ¼-elliptic or rarely asymmetrically oblong, subacute, less often acute or obtuse, the truncate base sometimes overlying the rachis, firmly herbaceous to subcoriaceous, occasionally coriaceous, mostly light green or olivaceous when dry; lower margin convex, upper margin straight or outward faintly convex; rarely both margins evenly convex; a distinct outer margin never developed. *Upper margin* with 1–6 but little oblique, narrow incisions, ½–1, rarely to 2 mm deep, reaching beyond the receptacle, with acute sinus, the lobes with flat or faintly convex or not rarely slightly concave edge, sometimes with small, pointed, horn-like extremities. Lobes of sterile pinnules crenate. *Upper pinnules* gradually reduced, with few or no incisions, some denticuliform ones confluent with the small, narrow leaf-apex. Veins immersed, evident or hidden, free, simple to twice forked, ½–1 mm apart. *Sori* interrupted by the incisions except in reduced pinnules, (1–)2–6 per pinnule, on 2 to 6 vein-ends, 1–6 mm long; receptacle straight or in short sori often convex. Indusium pale, entire to slightly erose, ½ mm wide (narrower in small forms), not quite reaching the margin to equaling it, with narrow, adnate ends, not reflexed but bulging at maturity. Spores medium brown, monoete, smooth, c. 55 by 38 µ.

Distr. Rhodesia, Mascarenes?, Madagascar, S. India, Ceylon, E. Himalaya, South and Central China, Japan, to *Malesia*: Malay Peninsula (Pahang, Perak), Sumatra, Java, Borneo, Philippines (Luzon, Mindanao, Negros, Panay, Mindoro), Talaud, Flores, New Guinea; Solomon Is. So far not collected in Celebes or the S. Moluccas.

*Ecol.* In open or slightly shaded places, often on escarpments and earth banks, apparently never in very dry places, from sea-level up to over 2000 m. Apparently common in most parts of its area, but rare east of Borneo and Java.

*Notes.* Freshly dried leaves have a distinct coumarin-like odour which may persist for several months in the herbarium.

In spite of its large area and rather diverse habitats *L. odorata* is only moderately variable. Only in extreme habitats aberrant forms occur, e.g. in exposed places in the mountains where the plants are dwarfed, with rigid pinnules and very dark axes ('*L. crassipes*'), or on moss-covered tree trunks and rocks where they are small but not rigid ('*L. loheriana*'. '*L. bullata*', '*L. plumula*', etc.).

Some small plants from the Philippines, e.g. CUMING 65, MANGUBAT B. Sc. 1354, MERRILL 5930, approach a small form that occurs in China

and Japan and is recently treated as a species, *L. japonica* (BAKER) DIELS, but is probably not more than a variety. They have, however, inter-

rupted sori, and are more probably extreme forms of *L. odorata* proper.

### 6. Section *Tropidolindsaea*

KRAMER, Act. Bot. Neerl. 6 (1957) 267.

Type species: *Lindsaea seemannii* J. SMITH.

Distr. Very discontinuous; the neotropical species for which the section was described occur in Costa Rica, Panama, W. Colombia, and Hispaniola; the sole paleotropical species occurs in the eastern Philippines.

Taxon. The combination of short-creeping rhizome, once-pinnate lamina that tapers basally as well as apically, and sclerotic, abaxially narrowed-rounded or carinate rachis, is sufficient for characterization. The pinnules are dimidiate and free-veined. The section is rather isolated in the genus; similarities with sect. *Osmolindsaea*, and with the Madagascan group segregated as *Sambirania* by TARDIEU-BLOT, may be due to true relationship or to convergence.

**34. *Lindsaea adiantoides*** J. SMITH in Hooker, Sp. Fil. 1 (1846) 204, pl. 61 C; COPELAND, Fern Fl. Philip. 1 (1958) 108; KRAMER, Blumea 15 (1968) 560; *non* (BLUME) KUHN (1869).—*L. humilis* KUHN in Miq. Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 278.—Type: CUMING 176, S. Camarines, Luzon (K; dupl. in B, BM, E, GH, P, W).

*L. tropidorachis* V.A.V.R. Bull. Jard. Bot. Btzg III, 5 (1922) 211; COPELAND, Fern Fl. Philip. 1 (1958) 108.—Type: RAMOS & EDANO B. Sc. 33778, Camarines, Luzon (BO; dupl. in B, BM, P, US).

*L. trimarginata* C. CHR. Dansk Bot. Ark. 9 (1937) 68.—Type: RAMOS & EDANO B. Sc. 33778, Camarines, Luzon (B; dupl. in BM, BO, P, US).—Fig. 24.

*Rhizome* very short-creeping or ascending, c. 1½ mm ø, with densely scaly apex; scales reddish brown, to almost 2 mm long, narrowly triangular, up to 5-seriate at base, biseriate below the glandular top-cell. Leaves very close; *petioles* blackish brown to atropurpureous, hardly shining, sharply triangular to base, with somewhat paler edges, the lateral faces much wider than the adaxial one, 3–10 cm long, much shorter than the lamina. *Lamina* simply pinnate, linear, c. 15–50 by 2–3 cm, widest mostly somewhat above the middle, with c. 25–40 pinnules to a side; rachis similar to the petiole, dark throughout, the edges often irregular and more pronouncedly pale. *Pinnules* firmly herbaceous, mostly olivaceous when dry,

subopposite almost throughout, spreading, close to overlapping in the upper part, gradually more remote in the lower part of the lamina, sessile; larger pinnules obliquely triangular, often subacute, 9 by 4½ to 15 by 9 mm; lower margin straight or slightly convex, ascending, upper margin straight or somewhat convex to the apex, with 1–3 narrow, unequal incisions that may reach down to the middle but are usually much shallower; a distinct outer margin not developed; bases of pinnules abruptly non-sclerotic, suggesting an articulation. *Lower pinnules* gradually very remote, reduced, auriculiform, incised; *upper pinnules* gradually and strongly reduced, little or not incised, 1 or 2 confluent with the lobed, non-caudate terminal segment. Veins slightly impressed above and prominent beneath, giving the pinnules a striate appearance, free, once or twice forked, ¼–¾ mm apart. *Sori* one per lobe, on 4–10 vein-ends; receptacle straight, with convex ends; indusium pale, herbaceous, erose, adnate at the sides, 0.6–0.9 mm wide, mostly not quite reaching the margin, scarcely reflexed at maturity. Spores yellowish, trilete, almost smooth, c. 38–41 µ.

Distr. *Malesia*: Philippines (Luzon, Samar, Dinagat, 9 coll.).

Ecol. Very few data; once reported from an open bank.

Note. This species is taxonomically isolated in Asia; its closest relatives are in tropical America.

### 7. Section *Psammolindsaea*

KRAMER, Blumea 15 (1968) 560.

Type and sole species the following, which has been included in *Schizoloma* and in *Isoloma*, but is not closely related to either.

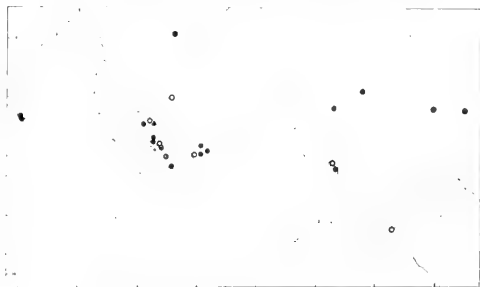
**35. *Lindsaea walkerae*** HOOKER, Sp. Fil. 1 (1846) 209, pl. 69 A.—*Isoloma walkerae* (HOOKER) PRESL, Epimel. Bot. (1851) 101.—*Schizoloma walkerae* (HOOKER) KUHN, Chaetopt. (1882) 346; DIELS in E. & P. Nat. Pfl. Fam. I, 4 (1902) 218; HOLTUM, Rev. Fl. Mal. 2 (1954) 344.—*Schizolegnia walkerae* (HOOKER) ALSTON, Bol. Soc. Brot. II, 30 (1956) 25.—Type: Mrs WALKER, Ceylon (K; dupl. in B).

*Rhizome* rather short- to long-creeping, 1½–2 mm ø; scales reddish brown to castaneous, almost linear, to 2 mm, to 4-seriate at base, there usually with laterally projecting cell partitions, the apex uniseriate, paler. Leaves rather close to 4 cm apart; *petioles* dark castaneous to black, lustrous, abaxially rounded, adaxially flattened or broadly sulcate, c. 10–45 cm long, much shorter to longer than the lamina. *Lamina* narrowly

oblong, 15–70 cm long, 1½–20 cm wide, simply pinnate, with 3–17 pinnules to a side and a free terminal one; rachis like the upper part of the petiole. *Pinnules* chartaceous to rigidly coriaceous, mostly olivaceous or dark brown when dry, paler beneath, sessile, obliquely to very strongly ascending, a few cm apart, opposite or subopposite throughout, linear, 2½–15 cm long, 4–8 mm wide, 6–20 times as long as wide; lower pinnules often more remote and sometimes slightly shortened; upper pinnules little or not reduced. Base of pinnules slightly unequally cuneate, the basiscopic side narrower, the dark colour of the rachis ending rather abruptly in the stalk-like base, but without an articulation; margin entire, somewhat revolute; upper half of pinnule narrowed, obtuse, if acuminate the tip still obtuse. *Terminal pinnule* conform, symmetric, occasionally joined to an upper lateral one or lobed at base, usually soriferous. Costa distinct, abaxially elevated, almost percurrent. Veins elevated on both sides, very oblique, less so towards their apices, 2–3 times forked, close, ¼–½ mm apart, free. *Sori* continuous, extending around the apices of the pinnules, the vein-ends below the receptacle thickened; indusium rigid, yellow or brown, entire, 0.4 mm wide, almost reaching the

margin, somewhat reflexed at maturity. Spores dark brown, trilete, smooth, 25–30 µ.

Distr. Ceylon, Indo-China, in *Malesia*: Malay Peninsula (Pahang, Trengganu, Johore, Malacca, Kedah), Singapore, Lingga Is., Banka, Borneo (Sarawak, Brunei, Kalimantan), W. New Guinea, Queensland; Carolines (Palau, Yap, Truk, Ponape). Rare in relation to its large area. Map 8.



Map 8. Distribution of *Lindsaea walkerae* Hook.

Ecol. In moist, open places, often on poor, acid soil, in swamps and by streams, at low elevation, but in Malaya also at 1000–1200 m.

#### 8. Section *Isoloma*

(J. SMITH) KRAMER, *Blumea* 15 (1968) 560.—*Isoloma* J. SMITH, Hook. J. Bot. 3 (1841) 414; Hist. Fil. (1875) 227.

Type species: *Lindsaea divergens* HOOKER & GREVILLE.

Distr. Throughout Malesia to western Polynesia. All species occur in the Flora Malesiana area.

Taxon. One of the groups treated most persistently as a distinct genus, mainly on account of the non-dimidiate, basally articulate pinnules. Other characters are the short-creeping rhizome, sclerotic axes, continuous sori, free veins, and trilete spores. The species of this section were in the past often placed in the genus *Schizoloma*, together with the species lacking dimidiate pinnules of sect. *Schizoloma* as treated here; but the resemblance is only a negative one.

36. *Lindsaea gueriniana* (GAUD.) DESVAUX, Prod. (1827) 312.—*Schizoloma guerinianum* GAUD. Ann. Sc. Nat. 3 (1824) 508; Freyc. Voy. Bot. (1829) 380, pl. 18.—*Isoloma guerinianum* (GAUD.) FÉE, Gen. Fil. (1852) 108; TARDIEU-BLOT, Not. Syst. 14 (1952) 332, *comb. superfl.*; COPELAND, Fern Fl. Philip. 1 (1958) 118.—*Guerinia articulata* J. SMITH, Hist. Fil. (1875) 272.—Type: GAUDICHAUD *s.n.*, Rawak, Papua Is. ('Moluccas') (P; dupl. in B, K, L).

*L. indurata* BAKER, J. Bot. 26 (1888) 324.—*Schizoloma induratum* (BAKER) C. CHR. Ind. Fil. (1906) 618.—*Isoloma induratum* (BAKER) TARDIEU-BLOT, Not. Syst. 14 (1952) 332; TAGAWA, Act. Phytotax. Geobot. 16 (1956) 174, *comb. superfl.* —Type: HOSE 221, Niah, Sarawak (K; dupl.? in BM).

*Schizoloma fuligineum* COPELAND, Philip. J. Sc. 1 (1906) Suppl. IV, 252, pl. 1 A.—*Isoloma fuligineum* (COPELAND) COPELAND, Philip. J. Sc. 78 (1949) 24.—Type: BOLSTER 276, Surigao, Mindanao (MICH; dupl. in P, US).

*Nephrolepis schizolomae* v.A.v.R. Bull. Jard. Bot. Btzig II, 7 (1912) 22.—*Schizoloma schizolo-*

*mae* (v.A.v.R.) v.A.v.R. Handb. Suppl. (1917) 214. —*Isoloma schizolomae* (v.A.v.R.) TAGAWA, Act. Phytotax. Geobot. 16 (1956) 174.—Type: GJELLERUP 1000, Mt Cycloop, W. New Guinea (BO).—Fig. 36.

*Rhizome* short- to moderately long-creeping, 1½–2½ mm ø; scales reddish to dark brown, lustrous, acicular, to 1½ mm long, uni- or biseriate or sometimes triseriate at the base. Leaves close or not; *petioles* reddish brown to fuscous, rarely blackish, rather dull, abaxially terete, adaxially upwards (sometimes pale) bimarginate, 5–25 cm long, much shorter than to about equalling the lamina. *Lamina* linear, 10–30 cm long, 1½–3½ cm wide, with up to c. 30 pinnules to a side; rachis medium to dark reddish brown, rarely blackish, dull, abaxially terete at the base, upwards gradually carinate, occasionally the keel extending to the base or present only near the apex, sometimes pale, adaxial side ± distinctly pale-margined. *Pinnules* chartaceous to coriaceous, usually drying brown, spreading or slightly upcurved, ½–1 times their width apart or less often contiguous, the lower ones remote, not reduced, the upper ones gradually reduced,



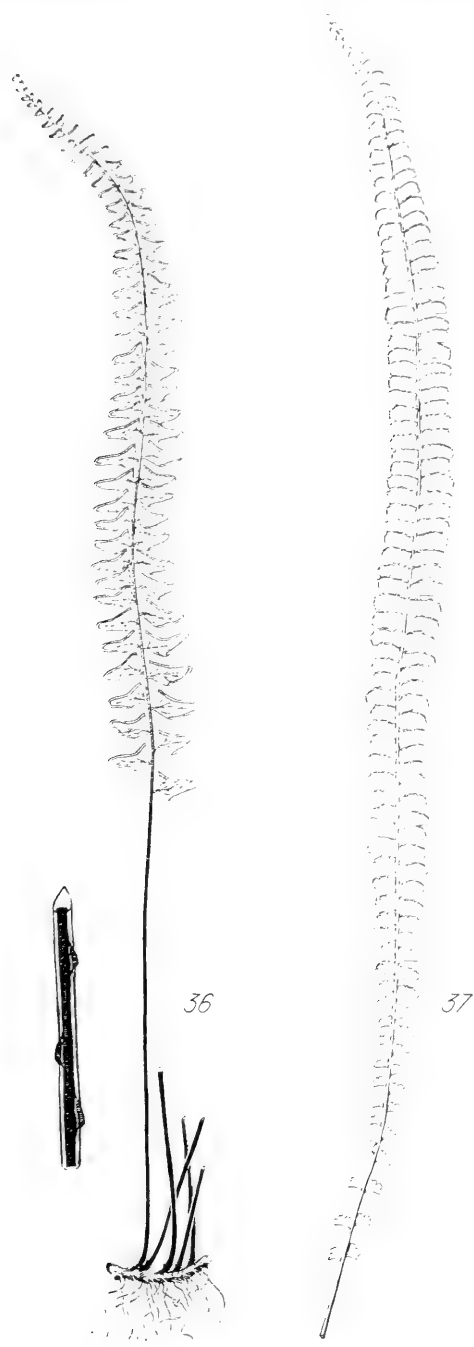


Fig. 36. *Lindsaea gueriniana* (GAUD.) DESV. Leaf,  $\times \frac{2}{5}$ , and portion of the rachis,  $\times 4$  (ZIPPELIUS s.n., L).—Fig. 37. *L. lucida* BL. ssp. *brevipes* (COPEL.) KRAMER. Lamina,  $\times \frac{2}{5}$  (BRASS 28253).

the smallest c. 1 or 2 mm long, connected with the small lanceolate terminal segment. Larger pinnules 7–18 mm long,  $3\frac{1}{2}$ –8 mm wide (excluding basal auricles), asymmetrically ovate, 2–2½ times as long as wide, obtuse to broadly rounded or rarely subacute, the acroscopic side of the base mostly with a small but distinct auricle often touching the rachis; articulation at the bases of the pinnules distinct. Veins immersed, obscure, once or twice forked, free; costa evident, not percurrent. Margin entire in fertile, crenate in sterile pinnules. *Sori* continuous, or absent from the pinnule-apices, always absent from the base of the lower margin; indusium rigid, subentire,  $\frac{1}{3}$ –½ mm wide, almost or quite reaching the margin, scarcely reflexed at maturity. Spores medium brown, trilete, almost smooth, c. 25–30  $\mu$ .

Distr. *Malesia*: Borneo (Sarawak), Celebes, Philippines (Sibuyan, Mindanao), Moluccas (Talaud, Halmahera), New Guinea (Japen, Waigeu, and other small islands; W. New Guinea, Papua); Solomon Is., Tahiti. Many collections are from small islands.

Ecol. In forests and open, drier places, terrestrial, sometimes on decaying wood; from sea-level up to 750 m.

Note. Some specimens, e.g. the type of *L. indurata* and TEYSMANN 11822 from Celebes, are atypical in having short, rounded pinnules. *L. gueriniana* is the most variable species of *sect. Isoloma*.

37. *Lindsaea ovata* J. SMITH in Hooker, Sp. Fil. 1 (1846) 204, pl. 64 A.—*Isoloma ovatum* (J. SMITH) PRESL, Epimel. Bot. (1851) 101; HOLTUM, Rev. Fl. Mal. 2 (1954) 338; COPELAND, Fern Fl. Philip. 1 (1958) 117.—*Schizoloma ovatum* (J. SMITH) COPELAND, Philip. J. Sc. 1 (1906) Suppl. IV, 252 ('*ovata*').—Type: CUMING 175, S. Camarines, Luzon (K; dupl. in B, BM, E, W).

*Schizoloma divergens* (HOOKER & GREVILLE) KUHN var. *auriculata* v.A.v.R. Handb. (1908) 278.—*Schizoloma auriculatum* (v.A.v.R.) v.A.v.R. Bull. Jard. Bot. Botz III, 5 (1922) 224.—*Isoloma auriculatum* (v.A.v.R.) TAGAWA, Act. Phytotax. Geobot. 16 (1956) 174.—Type: coll. not cited, 'Malaya' (specimens in herb. BO so annotated by v.A.v.R. are this species, but none is from Malaya).

*L. vrieseana* ROSENSTOCK, Meded. Rijksherb. 31 (1917) 4, nom. *subnud.*—Type: DE VRIESE 52, Borneo, *sine loc.* (L).

*Rhizome* short-creeping, 2 mm  $\phi$ ; scales dark castaneous, to  $1\frac{1}{4}$  mm long, almost acicular, up to 3-seriate at base, the apex long, uniseriate. Leaves clustered; *petioles* dark brown or black, lustrous, adaxially flattened and with two pale lateral ridges, abaxially usually keeled in the upper part, 6–18 cm long,  $\frac{1}{4}$  as long as to equaling the lamina. *Lamina* very narrowly oblong, 8–20 cm long, (1–)2½–4 cm wide, scarcely or not narrowed at the base, very shortly narrowed at the apex, with up to c. 30 pinnules to a side; rachis abaxially keeled or rarely basally subterete, the keel at least upward pale, otherwise the rachis like the

petiole. *Pinnules* chartaceous, mostly drying green, spreading or the basal ones deflexed, asymmetrically ovate to lanceolate, (5-)10-20 mm long, (3-)5-7 mm wide, 2-3½ times as long as wide, broadly rounded to subacute; the base at the upper side sharply rectangular to shortly auriculate. Lower pinnules not, a few upper ones slightly, or no upper pinnules reduced, the terminal pinnule free, rhombic to asymmetrically triangular. Articulation at pinnule-bases distinct. Fertile pinnules entire, sterile ones crenate-sinuate or rarely lobed. Veins immersed but abaxially mostly evident, mostly twice forked; costa weak, diagonal, not percurrent. *Sori* unbroken, occupying the upper and outer or also part of the lower margin; indusium yellowish to green, entire, 0.3-0.4 mm wide, equaling the margin, ± reflexed at maturity. Spores rather pale brown, trilete, verruculose, *c.* 22  $\mu$ .

Distr. *Malesia*: Malay Peninsula (Johore), Singapore, Anambas Is., Lingga Is., Banka, Borneo, Philippines (Luzon, Mindanao, no recent coll.). Apparently common only in Sarawak.

Ecol. Terrestrial and on rocks, often on poor soil and in moist places, from sea-level up to *c.* 1000 m.

**38. *Lindsaea pellaiformis* CHRIST**, Verh. Naturf. Ges. Basel 11 (1897) 430.—*Schizoloma pellaiforme* (CHRIST) C. CHR. Ind. Fil. (1906) 619.—*Iso-loma pellaiforme* (CHRIST) TARDIEU-BLOT, Not. Syst. 14 (1952) 332; TAGAWA, Act. Phytotax. Geobot. 16 (1956) 174, *comb. superfl.*—Type: SARASIN *s.n.*, SE. Celebes (P).

*Rhizome* short-creeping, 2 mm  $\phi$ ; scales medium brown, to 2½ mm long, acicular, the lower part biseriate, the upper half uniseriate. Leaves close; *petioles* dark castaneous to blackish, little lustrous to dull, abaxially terete, to *c.* 20 cm long. *Lamina* linear, to *c.* 30 cm long, to 5½ cm wide, widest a little above the base, with up to *c.* 35 pinnules to a side; rachis dark brown, dull, adaxially scarcely pale-margined, abaxially terete, the upper half ± pronouncedly carinate, the keel pale. *Pinnules* chartaceous to coriaceous, brown when dry, not contiguous, the basal ones remote, spreading or slightly falcately ascending, asymmetrically lanceolate, acute or rarely subacute, the larger ones 18-30 by 8 mm, 1½ to almost 4 times as long as wide (disregarding the auricle); base unequal, the basiscopic side narrower, the acroscopic side with a short (to 2 mm) subacute auricle. Margin entire, or notched in sterile pinnules, somewhat revolute. Basal pinnules slightly or not reduced; upper pinnules more strongly and gradually reduced, one or two small ones connected with the narrow, asymmetrically lanceolate terminal segment. Veins hidden, once or twice forked, oblique; costa almost percurrent. *Sori* continuous; indusium brown, rigid, entire, ½ mm wide, reaching the margin or nearly so, little reflexed at maturity. Spores medium brown, smooth, trilete, *c.* 27  $\mu$ .

Distr. *Malesia*: Celebes (3 coll.; beside the type KJELLBERG 2059 and 3561, both BO and S-PA).

Ecol. Terrestrial in rain-forest, 0-300 m.

Note. A little known species, close to *L. gueriniana* and perhaps only an extreme form of that variable species. The upper pinnules are less gradually reduced than in *L. gueriniana* but much more strongly so than in *L. ovata*.

**39. *Lindsaea philippinensis* KRAMER, nom. nov.**—*Schizoloma angustum* COPELAND, Philip. J. Sc. 1 (1906) Suppl. IV, 252, pl. 1 B.—*Iso-loma angustum* (COPELAND) TARDIEU-BLOT, Not. Syst. 14 (1952) 332; TAGAWA, Act. Phytotax. Geobot. 16 (1956) 174, *comb. superfl.*; COPELAND, Fern Fl. Philip. 1 (1958) 117, *comb. superfl.*; non *L. angusta* COPELAND (1952).—Type! FOXWORTHY 875, Palawan (MICH).

*Rhizome* short-creeping, 1½-2 mm  $\phi$ ; scales castaneous, lustrous, narrowly triangular to almost acicular, up to 5-seriate at base, the uniseriate apex relatively short. Leaves close; *petioles* brown to blackish, often ± persistently fibrillose-scaly, abaxially terete or upward ± distinctly keeled, *c.* 3-15 cm long, mostly much shorter than the lamina. *Lamina* linear, *c.* 10-30 cm long, 8-15 mm wide, with up to *c.* 35 pinnules to a side; rachis abaxially (in small leaves) entirely or (in larger ones) in the upper part keeled, the keel evanescent downward, adaxially sometimes pale-margined, otherwise dark brown to blackish, lustrous. *Pinnules* chartaceous or less often coriaceous, not or hardly contiguous, spreading, shortly and asymmetrically ovate, 5 by 4 to 8 by 6 mm, especially if large the base acroscopically distinctly angular and often slightly auriculate; upper pinnules gradually and ± strongly reduced, the terminal pinnule asymmetrically rhombic, free or connected with one upper pinnule; lower pinnules more remote, hardly or not reduced. Veins hidden, once forked or simple, a costa scarcely developed. *Sori* occupying the whole margin except the inner; indusium rigid, entire, *c.* 0.6-0.8 mm wide, not reaching the margin by half its width or less, little reflexed at maturity. Spores medium to dark brown, trilete, subglobose, smooth, *c.* 30-35  $\mu$ .

Distr. *Malesia*: Philippines (Luzon, Sibuyan, Palawan; 4 coll.).

Ecol. Among boulders on shaded riverbank, 800 m (one record).

Note. Doubtfully distinct from *L. jamesonioides*, the variability insufficiently known.

**40. *Lindsaea jamesonioides* BAKER**, J. Bot. 17 (1879) 39; HOOKER, Ic. Pl. 17 (1886) pl. 1626.—*Schizoloma jamesonioides* (BAKER) COPELAND, Philip. J. Sc. 1 (1906) Suppl. IV, 252.—*Iso-loma jamesonioides* (BAKER) TAGAWA, Act. Phytotax. Geobot. 16 (1956) 174; TARDIEU-BLOT, Not. Syst. 14 (1952) 332, with incorr. citation of author of basionym.—Type: BURBRIDGE *s.n.*, Mt Kinabalu, Sabah (K; dupl. in BM).

*Rhizome* short-creeping, 1½-2 mm  $\phi$ ; scales castaneous, narrowly triangular, to 3 mm long, up to 8-seriate at the base, with a short uniseriate apex. Leaves clustered; *petioles* black, dull, abaxi-

ally rounded, adaxially with a flat groove, often bearing some scattered dark narrow scales, 2–15 cm long, mostly considerably shorter than the lamina. *Lamina* linear, c. 6–25 cm long, 8–18 mm wide, with up to c. 50 pinnules to a side; rachis dark, not pale-margined, abaxially terete at base, upwards (starting at the lower to upper  $\frac{1}{3}$ ) with a keel that becomes progressively more acute above. *Pinnules* thickly coriaceous, sometimes wrinkled when dry, dark, half their width apart to (above) overlapping, spreading or slightly decurved, suborbicular to very shortly and asymmetrically ovate, the smaller ones 4 by 4 to 5 by 6 mm, the larger ones 8 by 7 mm; base unequal, basiscopically narrower, acroscopically broadly rounded to subangular; margin entire, also in sterile pinnules, thinner in texture and paler, not rarely somewhat revolute. Lower pinnules slightly or not remote and reduced, upper pinnules gradually and more strongly reduced but not confluent, the terminal pinnule free or nearly so, suborbicular or asymmetrically rhombic, occasionally lobed. Veins and *sori* as in the preceding species. Spores rather dark brown, trilete, smooth, c. 31–34  $\mu$ .

Distr. *Malesia*: Borneo (only known from Mt Kinabalu, Sabah; 11 coll.).

Ecol. On moist rocks, in forest and open places, c. 1500–3000 m.

Note. Young leaves described as bright red. See also the note after the preceding species.

41. *Lindsaea divergens* HOOKER & GREVILLE, Ic. Fil. (1831) pl. 226.—*Vittaria divergens* (HOOKER & GREVILLE) ROXBURGH ex GRIFFITH, Calc. J. Nat. Hist. 4 (1844) 510.—*Schizoloma divergens* (HOOKER & GREVILLE) KUHN, Chaetopt. (1882) 346; DIELS in E. & P. Nat. Pfl. Fam. I, 4 (1902) 219, *comb. superfl.*—*Isoloma divergens* (HOOKER & GREVILLE) J. SMITH, Hook. J. Bot. 3 (1841) 414; HOLTUM, Rev. Fl. Mal. 2 (1954) 337, f. 195; COPELAND, Fern Fl. Philip. 1 (1958) 117.—Type: probably a specimen without data from herb.

### 9. Section *Stenolindsaea*

KRAMER, *Blumea* 15 (1968) 561.

Type species: *Lindsaea lucida* BLUME.

Distr. A small section of only three species, occurring from China and Southern Japan to Fiji.

Taxon. Except for its constantly unipinnate leaves and basally tapering lamina (not always distinct in *L. lucida* BLUME) this section agrees in technical characters with *sect. Temnolindsaea*, but the groups are probably not closely related. The axes are abaxially bi-angular.

42. *Lindsaea lucida* BLUME, En. Pl. Jav. (1828) 216; HOLTUM, Rev. Fl. Mal. 2 (1954) 328, f. 187; KRAMER, *Blumea* 15 (1968) 567.—Type: BLUME s.n., Java (L).

*L. gracilis* BLUME, En. Pl. Jav. (1828) 217, *non* KLOTZSCH (1844); not or only in part of later authors.—Type: BLUME s.n., Java (L).

*L. concinna* J. SMITH, Hook. J. Bot. 3 (1841) 415, *nom. subnud.*; HOOKER, Sp. Fil. 1 (1846) 205, pl. 61 B.—*L. cultrata* (WILLD.) SWARTZ *var.*

HOOKER, said to be a WALLICH coll. from ROXBURGH's herbarium (K).

*Rhizome* short-creeping,  $1\frac{1}{2}$ –2 mm  $\sigma$ ; scales very dark brown, to c. 1 mm long, almost acicular, to 4-seriate at base, many scales largely or entirely uniseriate. Leaves clustered; *petioles* black, lustrous, abaxially terete, adaxially flattened and with 2 sharp, occasionally paler lateral ridges but hardly sulcate, to c. 15 cm long, mostly about  $\frac{1}{3}$  as long as the lamina. *Lamina* narrowly oblong, 15–50 cm long,  $3\frac{1}{2}$ –6 cm wide, narrowed at both ends but more gradually at the base, widest about the middle; rachis like the petiole, abaxially keeled only near the apex. *Pinnules* spreading or the upper ones ascending, the basal ones deflexed, contiguous with their broadened bases, elongate-ligulate, chartaceous to subcoriaceous, dark green or brown when dry, the lower side markedly paler, often somewhat glaucous; larger pinnules  $1\frac{3}{4}$ –3 cm long, 3–4 mm wide (not counting the broadened base), little narrowed to the obtuse apex; acroscopic side of base with an obtuse or subacute auricle that does not touch the rachis; basiscopic side less broadened. Lowermost, reflexed pinnules mostly several mm long, scarcely auriculiform; uppermost pinnules more strongly reduced, a few confluent with the lobate-hastate, lanceolate terminal segment, or a free, scarcely lobed, lanceolate pinnule present. Margin entire, often revolute when dry, then the pinnules seemingly acute. Veins immersed, obscure, lax, very oblique, mostly once or twice forked. *Sori* continuous, absent from the basal auricle and sometimes, from the apex; indusium 0.2–0.3 mm wide, pale, entire, not reaching the margin by less than its width. Spores medium brown, trilete, smooth, c. 17–19  $\mu$ .

Distr. S. Thailand; *Malesia*: Malay Peninsula, Singapore, Riouw Is., Lingga Is., Sumatra, Banka, Borneo, Philippines (Palawan).

Ecol. Terrestrial in forest, from sea-level up to c. 800 m.

*concinna* (J. SMITH) DOMIN, Bibl. Bot. 20 (1915) 82.—Type: CUMING 198, Luzon (K); dupl. in B, E, GH, HBG, L, P, SING, US, W).

*L. securifolia* PRESL ex GOLDMANN, Nova Acta Ac. Caes. Leop.-Car. Suppl. I ad 16 (1843) 464; KUNZE, Farnkr. 1 (1846) 204, pl. 85 f. 1; COPELAND, Fern Fl. Philip. 1 (1958) 108.—*L. cultrata* (WILLD.) SWARTZ *var. securifolia* (PRESL) BAKER in Beccari, *Malesia* 3 (1886) 36.—Type: MEYEN s.n., Manila, Luzon (dupl. in B, HBG).

*L. colobodes* KUNZE, Bot. Zeit. (1846) 446.—Type: ZOLLINGER 1507, Java (dupl. in B, HBG, W, Z).

*L. lobbiana* HOOKER, Sp. Fil. 1 (1846) 205, pl. 62 C; HOLTUM, Gard. Bull. S. S. 5 (1930) 61.—*L. cultrata* (WILLD.) SWARTZ var. *lobbiana* (HOOKER) BECCARI, Malesia 3 (1886) 36.—Type: LOBB s.n., Java (K).

*L. crenulata* FÉE, Gen. Fil. (1852) 105, pl. 28 f. 2.—Type: GRIFFITH s.n., 'Malacca?' (n.v.).

*L. gracilis* BLUME var. *major* METT. ex KUHN in Miq. Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 276.—Lectotype: HASSKARL s.n., Java (L).

*L. gracillima* COPELAND in Perkins, Fragm. Fl. Philip. (1905) 181.—Type: MERRILL 287, Caraballo Sur, Luzon (dupl. in B, BO, US).

*L. propria* v.A.v.R. Bull. Jard. Bot. Btzg II, 16 (1914) 20.—Type: BACKER 6084, Mt Handjawan near Bogor, Java (BO).

*Rhizome* short- or very short-creeping, c. 1 mm ø; scales rather dark brown, to 1 mm long, acicular, to 6-seriate at the base, the greater part uni- or biseriate. Leaves very close; *petioles* stramineous to reddish brown, quadrangular, adaxially hardly sulcate. *Lamina* linear, c. 10–40 cm long, c. 10–25 times as long as wide, simply pinnate; rachis like the petiole. *Pinnules* spreading or slightly ascending or decurved, the upper ones subcontiguous to slightly overlapping, the lower ones gradually more widely spaced; larger pinnules 1½–2½ times as long as wide, firmly herbaceous, medium to dark green or olivaceous when dry. Upper pinnules reduced; larger pinnules mostly incised. Veins immersed, evident, once or twice forked or the outer ones simple, free; a costa scarcely developed. *Indusium* pale, entire; spores trilete.

#### KEY TO THE SUBSPECIES

1. Petiole 3–15 cm long,  $\frac{1}{5}$ – $\frac{1}{2}$  of the length of the lamina; indusium 0.3–0.4 mm wide, at least in the inner sori almost or quite reaching the margin. . . . . 1. *ssp. lucida*
1. Petiole 1–2(–4) cm long,  $\frac{1}{15}$ – $\frac{1}{20}$  of the length of the lamina; indusium 0.2 mm wide, more strongly intramarginal. . . . . 2. *ssp. brevipes*

#### 1. *ssp. lucida*.

*Petioles* c. 3–15 cm long,  $\frac{1}{5}$ – $\frac{1}{2}$  as long as the lamina. *Lamina* 1–3 cm wide, with c. 25–60 pinnules to a side. *Larger pinnules* 5 by 3 to 15 by 6 mm, almost 2–2½ times as long as wide, rather variable in shape, ¼-elliptic or subtriangular if small, ligulate to subtrapeziform or elongate-¼-elliptic if larger, the apex subacute to broadly rounded, the lower margin ± straight, the upper margin especially in small pinnules evenly convex and no separate outer margin developed, or outward increasingly convex, the outer margin ± distinct. *Upper pinnules* gradually and suddenly rather strongly reduced, some denticuliform ones connected with the narrow, small, lobed, usually obtuse and often fertile leaf-apex. *Lower pinnules* not reduced or more often slightly to strongly

and gradually reduced, then often somewhat decurved, in extreme cases only 2 mm long but usually larger, the petiole below them well developed. *Sterile pinnules* crenate; *fertile pinnules* if very small entire or with 1 or 2 incisions on the outer/upper margin to ½ mm deep, in larger forms rarely entire, mostly at least with one incision of ½–1 mm between upper and outer margin, most commonly the upper margin with 1–3 incisions of c. 1 mm (but up to 2 mm), the outer entire. *Sori* continuous except as interrupted by the incisions, on 2–7(–10) vein-ends, the outermost usually longer; upper, smaller pinnules entire, fertile; lower, reduced ones, if any, partly or entirely sterile. Receptacle straight, or concave in the outer sorus. *Indusium* 0.3–0.4 mm wide, little narrowed at the edges, almost or quite reaching the margin, or more strongly intramarginal in the outer sori, reflexed or not at maturity. Spores yellowish brown, smooth, c. 25–28 µ.

Distr. Central Himalaya, S. China, and Ryu Kyu Is. to Malesia: throughout Malesia (except Lesser Sunda Is.) but rare in New Guinea; Palau Is.

Ecol. Terrestrial or on rocks, rarely epiphytic, in primary forests, from 400–1600 m, sporadically to sea-level.

2. *ssp. brevipes* (COPELAND) KRAMER, Blumea 15 (1968) 567.—*L. brevipes* COPELAND, Philip. J. Sc. 6 (1911) Bot. 83; *ibid.* 78 (1949) 19.—Type: KING 237, Papua (MICH; dupl. in BO).—Fig. 37.

*Petioles* 1–2(–4) cm long,  $\frac{1}{15}$ – $\frac{1}{20}$  of the length of the lamina. *Lamina* 1¼–2 cm wide, widest above the middle, very gradually long-tapering at the base, rather shortly acuminate at the apex, with 25–80 pinnules to a side. *Larger pinnules* 6–9 mm long, 3–4 mm wide, mostly ¼-elliptic, occasionally subligulate, mostly with straight lower and outward increasingly convex upper margin and ± distinctly angular at the junction of outer and upper margins. Incisions various, occasionally none, usually 1–3 per pinnule, ½–1, sometimes to 2 mm deep and then reaching to or the outer ones beyond the middle. *Upper pinnules* as in *ssp. lucida*. *Lower pinnules* from above the middle of the lamina downward gradually and strongly reduced, many lower ones auriculiform, 1–2 mm long, sterile, crenate to cleft. *Indusium* 0.2 mm wide, not reaching the margin, usually reflexed and ± concealed at maturity. Spores c. 20 µ, otherwise as in *ssp. lucida*.

Distr. Malesia: S. Moluccas (Ceram, Ambon), New Guinea (Waigeu, W. New Guinea, Terr. of New Guinea, Papua); Admiralty Is. (Los Negros), Solomon Is.

Ecol. Terrestrial and on rocks and tree-bases, in forests, from sea-level up to c. 1000 m.

Note. This is a somewhat variable species. The extremes certainly look different, e.g., the form described from (and particularly common in) the Philippines as *L. concinna* with short pinnules and basally rather strongly tapering

lamina; but they all grade into each other. *Ssp. brevipes* alone seems reasonably distinct, although there are a few intermediates, notably in New Guinea.

**43. *Lindsaea bakeri*** (C. CHR.) C. CHR. Ind. Fil. Suppl. 3 (1934) 121; COPELAND, Philip. J. Sc. 78 (1949) 17.—*Davallia lanceolata* BAKER, Kew Bull. (1899) 119; non *Asplenium lanceolatum* HUDSON (1762), nec *L. lanceolata* LABILLARDIÈRE (1806).—*Asplenium bakeri* C. CHR. Ind. Fil. (1906) 102.—Type: GIULIANETTI & ENGLISH s.n., Vanape valley, Papua (K).

*L. trichophylla* COPELAND, Philip. J. Sc. 6 (1911) Bot. 83.—Type: KING 262, Papua (MICH; dupl. in BRI, ?P).

*L. schlechteri* BRAUSE, Bot. Jahrb. 49 (1912) 28, f. 1 J; COPELAND, Philip. J. Sc. 78 (1949) 17.—Type: SCHLECHTER 19395, Pema, Terr. of New Guinea (B).

*L. ledermanni* BRAUSE, Bot. Jahrb. 56 (1920) 130.—Lectotype: LEDERMANN 10017, Lordberg, Sepik R. region, Terr. of New Guinea (B; dupl. in S-PA).—Fig. 22.

*Rhizome* short-creeping,  $\frac{1}{2}$ – $\frac{2}{3}$  mm  $\sigma$ ; scales not seen. Leaves clustered; *petioles* abaxially obtusely to sharply bi-angular, 1–10 cm long, shorter than to about equaling the lamina. *Lamina* linear, once pinnate + deeply uni- to tripinnatifid, narrowed on both sides or truncate at the base, with c. 20–50 pinnules to a side; rachis abaxially sharply bi-angular, hardly sulcate. *Pinnules* subcontiguous to slightly overlapping, the basal ones farther apart, spreading, slightly ascending, or somewhat falcately decurved, thinly herbaceous, medium to dark green when dry, 5 by  $2\frac{1}{2}$  mm to 3 by  $1\frac{1}{2}$  cm, semi-ovate to suboblong in outline,  $2$ – $2\frac{1}{2}$  times as long as wide, very deeply incised from the upper margin, with 3–9 primary segments (in one plant at the apex also incised from the lower edge), these rarely all simple, mostly at least the basal ones once or twice forked, or in very large pinnules acroscopically-dimidiately or subequally pinnatifid, then some of the secondary segments again bifid; ultimate lobes  $\pm$  divergent, linear, often with revolute margin, gradually but slightly broadened upward, then suddenly broadened at the sorus, the wing connecting them about as wide as the segments. Veins immersed, single or

very rarely paired in the lobes. *Upper pinnules* gradually reduced, confluent into a pinnatifid leaf-apex; basal pinnules  $\pm$  reduced. *Sori* uni- or binerval; indusium pale or greenish, delicate, subentire, laterally free,  $\frac{1}{4}$  mm wide, not reaching the margin by its width or a little less, not strongly reflexed at maturity but the sporangia often spreading beyond the margin. Spores pale brown, trilete, smooth, c. 20  $\mu$ .

#### KEY TO THE VARIETIES

1. Axes stramineous to medium brown; ultimate lobes 0.3–0.5 mm wide, at the sorus  $\frac{1}{2}$ –1 mm wide; sori hardly ever binerval. **1. var. *bakeri***
1. Axes medium to dark brown; ultimate lobes 0.6–1 mm wide, 0.8–1.2 mm wide at the sorus; sori not rarely binerval. **2. var. *pyncophylla***

#### 1. var. *bakeri*.—Fig. 22.

*Petioles* stramineous to medium brown, then not rarely pale-angled. *Lamina* 4–30 cm long, 1–6 cm wide; rachis stramineous or basally pale brown. *Ultimate lobes* of the pinnules divergent, linear-capillary, 0.3–0.5 mm wide, at the sorus 0.5–1 mm wide, their apices erose, rounded or subtruncate, not rarely laterally bicorniculate, rounded-subacute when sterile. Veins evident. *Sori* very rarely binerval, 0.3–0.8 mm long; base of indusium  $\pm$  straight.

Distr. *Malesia*: Moluccas (Morotai), New Guinea (all Div.).

Ecol. Terrestrial, on banks and mounds, and on tree-bases, in forests, from c. 80–1000 m.

**2. var. *pyncophylla*** KRAMER, Blumea 15 (1968) 567.—Type: BRASS 6838, Fly R. region, Papua (GH).

*Petioles* and rachises medium to dark brown, pale-margined. *Lamina* to 12 by 3 cm, little narrowed at base. *Pinnule lobes* not capillary, 0.6–1 mm wide, at the sorus 0.8–1.2 mm wide, little divergent, apically hardly or not erose. Veins concealed. *Sori* not rarely binerval, to 1 mm long. Base of indusium not rarely strongly concave.

Distr. *Malesia*: Papua (2 coll.; beside the type also BRASS 6902, BM, GH, from the same area).

Ecol. 80–100 m.

### Subgenus *Odontoloma*

(HOOKER) KRAMER, Blumea 15 (1968) 561.—*Davallia* subg. *Odontoloma* HOOKER, Sp. Fil. 1 (1845) 174.—*Odontoloma* J. SMITH, Hook. J. Bot. 3 (1841) 415, nom. subnud.; in Hooker & Bauer, Gen. Fil. (1842) pl. 114 B; non H.B.K. (1820) (*Compositae*).

Type species: *Dicksonia repens* BORY = *Lindsaea repens* (BORY) THWAITES.

### 10. Section *Odontoloma*

Type species: As the subgenus.

Distr. Mascarene Islands, Ceylon, NE. India, Ryu Kyu Is. to Hawaii, and NE. Australia.

Taxon. A group of closely related species with closed xylem strand, = persistently scaly rhizome, and

unipinnate leaves. The differences between most taxa are slight, and the present species and varieties are not quite satisfactory.

44. *Lindsaea glandulifera* v.A.v.R. Bull. Jard. Bot. Btzig II, 1 (1911) 9.—Type: KOORDERS 15415, Besuki, Java (BO; dupl. in K, L).

*L. repens* (BORY) THWAITES var. *laciniata* METT. ex KUHN in Miq. Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 277.—Lectotype: ZOLLINGER II 3712, Mt Idjen, Java (L; dupl. in B, BM, P, W).—Fig. 49.

*Rhizome* long-scandent, brown, 1–2 mm  $\phi$ , dorsally  $\pm$  persistently scaly; scales honey-coloured to pale golden-brown, narrowly triangular, to c. 25-seriate at base, to 4 by 1 mm, the uniseriate apex of up to 10 cells. Leaves 1–3 cm apart, issuing under an acute angle; *petiole* almost wanting to c. 2 cm long, stramineous, darker and verruculose at base, sharply quadrangular almost to the base, laterally and sometimes also adaxially broadly and shallowly sulcate. *Lamina* linear, 20–35 cm long,  $1\frac{1}{2}$ – $2\frac{1}{2}$  cm wide, simply pinnate, with c. 40–60 pinnules to a side; rachis stramineous, abaxially flat, sharply bi-angular, adaxially broadly sulcate, laterally  $\pm$  sulcate. *Pinnules* regularly spaced except at the base, not contiguous, spreading or mostly somewhat ascending, at least the basal ones inserted below the level of the adaxial-lateral ridges, asymmetrically elongate-triangular, herbaceous, bright green to olivaceous when dry, the largest 10–12 by 4–5 mm,  $\pm$  evenly narrowed from base to apex, cuneate at base, narrowed-rounded at apex; lower margin mostly somewhat convex; upper margin outward convex, incised, with mostly 3 major, oblique incisions reaching down to  $\frac{1}{3}$  or  $\frac{1}{2}$  or occasionally to  $\frac{3}{4}$ , the lobes not parallel-sided but narrowed, rounded at apex, the largest lobes shallowly incised again. Pinnules of juvenile plants and sterile ones not more incised. *Lower pinnules* gradually remote and reduced, largely sterile; *upper pinnules* gradually and strongly reduced, confluent into a pinnatifid leaf-apex. Veins immersed, evident, simple or once forked. *Sori* one per lobe, on the ends of 1 or 2 connivent veins; indusium transversely elongate to hippocrepiform, with  $\pm$  concave base, free at the narrowed sides,  $\frac{1}{3}$ –1 mm long, c.  $\frac{1}{3}$  mm wide, not reaching the margin by its width or a little less, reflexed and concealed at maturity. Spores pale brown, trilete, nearly smooth, c. 22  $\mu$ .

Distr. Ceylon; in *Malesia*: East Java, Lesser Sunda Islands (Lombok, Sumbawa). Map 10.

Ecol. Epiphytic in mountain forests, c. 1000 m. Apparently rare.

45. *Lindsaea oblanceolata* v.A.v.R. Bull. Jard. Bot. Btzig II, 23 (1916) 15.—Type: AJOEB 100, Rimbo Pengadang, Bencoolen, Sumatra (BO; dupl. in L).

*L. subsemilunularis* v.A.v.R. Bull. Jard. Bot. Btzig II, 28 (1918) 31.—Type: HALLIER 591, Mt Damus, Borneo (BO).

? *L. lunulata* v.A.v.R. Bull. Jard. Bot. Btzig II, 11 (1913) 15.—Type: RAAP 634, Batu Islands (BO).

*L. pectinata* auct. non BLUME; HOLTUM, Gard. Bull. S. S. 5 (1930) 62; Rev. Fl. Mal. 2 (1954) 324.

*Rhizome* long-scandent, dark castaneous, 1–2 mm  $\phi$ ; scales when mature dark brown, narrowly triangular or lanceolate, to  $2\frac{1}{2}$  by  $\frac{3}{4}$  mm, up to c. 15-seriate at the base, the uniseriate apex very short. Leaves remote, 1–5 cm apart, not rarely issuing almost at right angles; *petioles* abaxially bi-angular, mostly brown and pale-angled but sometimes quite stramineous except at the base, 2–10 cm long (exceptionally longer), much shorter than the lamina, at the most half as long. *Lamina* linear, 15–50 cm long (rarely shorter but fertile), 2–4  $\frac{1}{2}$  cm wide, 5–15 times as long as wide, in juvenile plants usually broadest just below the apex, in full-grown ones narrowed to both ends, simply pinnate, with c. 20–60 pinnules to a side; rachis pale brown, stramineous-margined, or stramineous throughout, at the base sharply quadrangular with flat or slightly convex faces, the pinnules in the basal part inserted below the adaxial face, upward sulcate. *Pinnules* herbaceous or chartaceous, dark green or blackish when dry, sometimes described as glossy, less than their width apart to slightly overlapping, spreading, the lower ones not rarely deflexed and the upper ones somewhat ascending, dimidiate-ligulate or trapezoidal, broadly rounded or narrowed-rounded at the apex; larger pinnules 10 by 5 to 22 by 9 mm, 2–2  $\frac{1}{2}$  times as long as wide, entire; sterile or incompletely fertile pinnules crenate. *Lower pinnules* gradually reduced but few or none so strongly as to be auriculiform; *upper pinnules* not reduced in juvenile plants, increasingly so in older ones, in the largest leaves several very small ones connected with the small lanceolate terminal segment; small leaves with a large, free, very obtuse, transversely elongate, asymmetrically lance-shaped or flabellate or broadly lanceolate terminal pinnule, with all intermediates between the two extremes possible. Veins immersed,  $\pm$  evident, once or twice forked, free,  $\frac{3}{4}$ –1  $\frac{1}{4}$  mm apart. *Sori* continuous, occupying all vein-ends, interrupted only in incompletely fertile pinnules; indusium 0.3–0.5 mm wide, pale, subentire, not reaching the margin by  $\frac{1}{2}$ –1 times its width. Spores yellowish brown, trilete, almost smooth, c. 20  $\mu$ .

Distr. Annam, Peninsular Thailand; in *Malesia*: Malay Peninsula, Sumatra, West Java, Borneo, Philippines (Luzon, Leyte, Mindanao), Moluccas (Ceram, Ambon). Not yet found on Celebes.

Ecol. On tree trunks, or occasionally terrestrial, 800–1800 m, rarely lower. Apparently uncommon in most parts of its area.

Notes. Incompletely fertile leaves without rhizome cannot always be distinguished from *L. repens*. Juvenile plants lack the deeply incised pinnules of that species.

The type of *L. lunulata* v.A.v.R. is a juvenile,

nearly quite sterile plant of uncertain identity.

46. *Lindsaea repens* (BORY) THWAITES, En. Pl. Zeyl. (1864) 388; BEDD. Ferns S. Ind. (1864?) pl. 209; CHRIST, Geogr. d. Farne (1910) f. 46, 47; HOLTUM, Gard. Bull. S. S. 5 (1930) 63, f. 4.—*Dicksonia repens* BORY, Voy. 2 (1804) 323.—*Davallia repens* (BORY) DESVAUX, Prod. (1827) 314, non KUHN (1867).—*Odontoloma repens* (BORY) PRESL, Epimel. Bot. (1851) 97.—*Acrophorus repens* (BORY) MOORE, Ind. Fil. (1857) 91.—*Davallia boryana* PRESL, Rel. Haenk. (1825) 66, as to type only.—*Saccoloma boryanum* (PRESL) PRESL, Tent. Pterid. (1836) 126.—*Odontoloma boryanum* (PRESL) J. SMITH, Hook. J. Bot. 3 (1841) 415 ('boryana').—*L. boryana* (PRESL) BRAUSE, Bot. Jahrb. 56 (1920) 129.—Type: BORY s.n., Bourbon (= Réunion) (P; dupl. in B, BM).—*L. bantamensis* BLUME, En. Pl. Jav. (1828) 218.—Type: BLUME s.n., Bantam, Java (L).

*L. hymenophylloides* BLUME, l.c.; not or in part only of later authors.—*Acrophorus hymenophylloides* (BLUME) MOORE, Ind. Fil. (1857) 2.—*Davallia hymenophylloides* (BLUME) BAKER, Syn. Fil. ed. 1 (1867) 93.—*Odontoloma hymenophylloides* (BLUME) J. SMITH, Hist. Fil. (1875) 269.—Type: BLUME s.n., Java (L).

*L. pectinata* BLUME, En. Pl. Jav. (1828) 217; not of HOLTUM, Rev. Fl. Mal. 2 (1954) 324, nor of COPELAND, Fern Fl. Philip. 1 (1958) 104.—Type: BLUME s.n., Java (L).

*Davallia hemiptera* BORY, Bél. Voy. Bot. 2 (1833) 73, pl. 7 f. 2.—*Saccoloma hemipterum* (BORY) PRESL, Tent. Pterid. (1836) 126.—*Odontoloma hemipterum* (BORY) PRESL, Epimel. Bot. (1851) 98.—*Acrophorus hemipterus* (BORY) MOORE, Ind. Fil. (1861) 295.—*L. repens* (BORY) THWAITES var. *hemiptera* (BORY) v.A.v.R. Handb. (1908) 261; not *L. hemiptera* KRAMER (1957).—Type: BÉLANGER s.n., Java (P).

*L. oblongifolia* REINW. ex HOOKER, Sp. Fil. 1 (1846) 206, at least in part.—Type: CUMING 186, S. Camarines, Luzon (K; dupl. in B, GH, L, SING, US, W).

*Davallia delicatula* CHRIST, Verh. Naturf. Ges. Basel 11 (1895) 224, pl. 3, 1–3.—*L. delicatula* CHRIST, l.c., nom. altern. illeg.—Type: SARASIN 987, Borau, Celebes (P).

*L. sessilis* COPELAND, Philip. J. Sc. 6 (1911) Bot. 82; *ibid.* 78 (1949) 16.—Type: KING 244, Papua (MICH).

*L. repens* (BORY) THWAITES var. *intermedia* CHRIST, Ann. Cons. Jard. Bot. Genève 15/16 (1912) 197.—Type: HOCHREUTINER 782, Mt Salak, Java (n.v.).

*L. foersteri* ROSENSTOCK in Fedde, Rep. 12 (1913) 527; COPELAND, Philip. J. Sc. 78 (1949) 17.—Type: KEYSER 193, Mt Sattelberg, Terr. of New Guinea (B; dupl. in MICH).

*L. pectinata* (BORY) THWAITES f. *dimorpha* ROSENSTOCK in Fedde, Rep. 13 (1914) 213.—Type: GRASHOFF, 59, W. Sumatra (S-PA).

*L. repens* (BORY) THWAITES f. *truncatiloba* ROSENSTOCK, l.c. 214.—Type: GRASHOFF 60, W. Sumatra (S-PA).

*L. longa* COPELAND, Philip. J. Sc. 46 (1931) 216; Fern Fl. Philip. 1 (1958) 103.—Type: EDAÑO B.Sc. 77978, Mt Balabag, Palawan (MICH; dupl. in GH).

*L. sagincola* WAGNER & GREYER, Un. Cal. Publ. Bot. 23 (1948) 34, pl. 9.—Type: GREYER & WAGNER 4010, Los Negros, Admiralty Is. (dupl. in MICH, US).

*L. cultripinna* COPELAND, Philip. J. Sc. 81 (1952) 6; Fern Fl. Philip. 1 (1958) 103.—Type: SULIT P.N.H. 8718, Mt Katanglad, Mindanao (MICH).

? *L. roxasii* COPELAND, Philip. J. Sc. 81 (1952) 6; Fern Fl. Philip. 1 (1958) 102.—Type: COPELAND P.P.E. 259, Mindanao (MICH).—Fig. 43–45.

*Rhizome* long-scandent, castaneous; scales triangular, narrowly triangular, or lanceolate, with a very short uniseriate apex, the larger ones  $2\frac{1}{2}$ – $3\frac{1}{2}$  mm long. *Leaves* one to a few cm apart, issuing under a small angle; petioles stramineous to pale brown with dark base, quadrangular, the faces not sulcate. *Lamina* linear, simply pinnate, narrowed at both ends, or sometimes little narrowed at the base; rachis stramineous, quadrangular, adaxially at the base = convex, the pinnules inserted below the edges, upwards sulcate, bearing the pinnules at its edges. *Pinnules* numerous, herbaceous, elongate-triangular, ligulate, or  $\frac{1}{4}$ -elliptic, the upper ones gradually and strongly reduced, a few confluent into a pinnatifid leaf-apex. Upper margin shallowly incised. *Juvenile plants* with deeply (bi)pinnatifid, thin pinnules, sterile; but in transitional cases leaves may be fertile in the upper part and bear sterile pinnules of the juvenile shape in the basal part. Veins immersed free, once or twice forked. *Sori* interrupted. Spores pale brown, trilete, smooth, c. 22–26  $\mu$ .

Distr. Mascarenes, Ceylon, Assam, Indo-China to *Malesia*, Queensland, and Hawaii.

#### KEY TO THE VARIETIES

1. Rhizome delicate, less than 1 mm  $\phi$ 
  2. var. *delicatula*
1. Rhizome of full-grown plants ( $1\frac{1}{2}$ )–2–3 mm  $\phi$ .
2. Indusium with strongly concave base, subhippocrepiform; most sori uninerval and round, occasionally some binerval and crescent-shaped; margin regularly incised, the incisions reaching down almost twice the distance from receptacle to margin; most lobes rounded; sporangia at full maturity strongly laterally spreading; petiole very short
  1. var. *sessilis*
2. Indusium with weakly concave, straight, or somewhat convex base, or, if more strongly concave, the sori almost marginal; sori uniovate plurinerval.
3. At least the broader basal lobes of fully fertile pinnules truncate; most or all sori straight and plurinerval (except in incomplete fertile pinnules); most incisions not reaching the level of the receptacle.

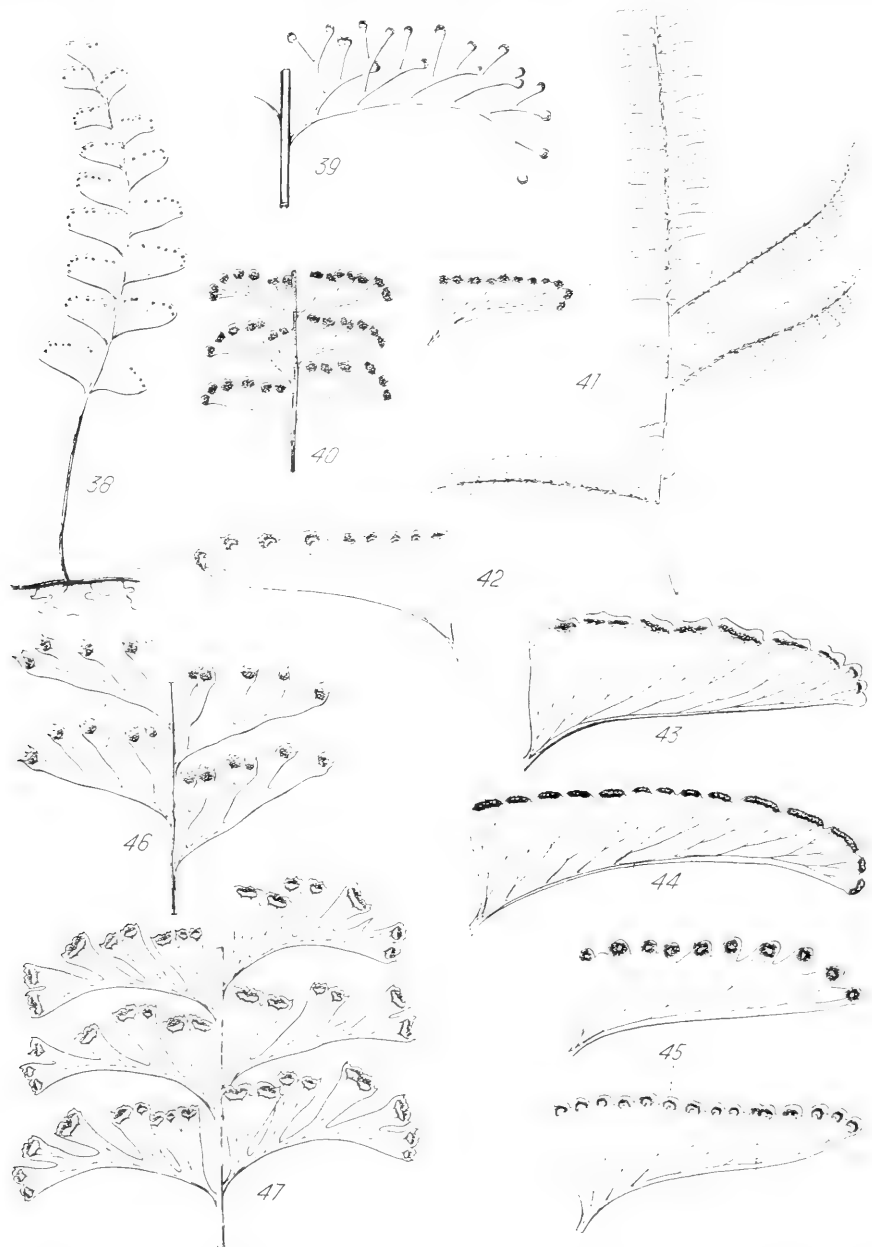


Fig. 38. *Lindsaea weneri* ROSENSTOCK. Leaf,  $\times \frac{1}{2}$  (SURBECK s.n., L).—Fig. 39. *L. versteegii* (CHRIST) v.A.v.R. Pinnule and part of rachis,  $\times 2\frac{1}{2}$  (VERSTEEG 1222).—Fig. 40. *L. rosenstockii* BRAUSE. Part of a pinna,  $\times 1\frac{1}{2}$  (WOMERSLEY 8346).—Fig. 41. *L. microstegia* COPEL. Basal part of lamina,  $\times \frac{1}{2}$ , pinnule,  $\times 1\frac{1}{2}$  (DARBYSHIRE 275).—Fig. 42. *L. merrillii* COPEL. ssp. *merrillii*. Pinnule,  $\times 2\frac{1}{2}$  (ELMER 13488).—Fig. 43–45. *L. repens* (BORY) THWAITES.—Fig. 43. var. *pectinata* (BL.) METT. ex KUHN. Pinnule,  $\times 1\frac{1}{2}$  (BACKER 530).—Fig. 44. var. *submarginalis* KRAMER. Pinnule,  $\times 2$  (SURBECK 946).—Fig. 45. var. *sessilis* (COPEL.) KRAMER. Pinnules of two forms, above,  $\times 3$  (NGF 8493), below,  $\times 2$  (BRASS 23394).—Fig. 46. *L. capillacea* CHRIST. Part of a lamina,  $\times 4$  (ELMER 17635).—Fig. 47. *L. fissa* COPEL. Part of a lamina,  $\times 2\frac{1}{2}$  (MERRILL 9527).



4. Sori very close to the margin, the sporangia at full maturity often adaxially visible; pinnules 3-4 times as long as wide

4. *var. submarginalis*

4. Sori more distinctly intramarginal, the sporangia never adaxially visible; pinnules  $2\frac{1}{2}$ -3 times as long as wide. 3. *var. pectinata*

3. Lobes narrowed-rounded, irregular, with nearly marginal, mostly uni- or binerval  $\pm$  round sori; incisions mostly reaching 3 or more times the distance from margin to receptacle; petiole often well-developed.

5. *var. pseudohemiptera*

1. *var. sessilis* (COPELAND) KRAMER, Blumea 15 (1968) 568.—*L. sessilis* COPELAND.—*L. foersteri* ROSENSTOCK.—*L. longa* COPELAND.—*L. cultripinna* COPELAND.—Fig. 45.

*Rhizome* c. 2 mm  $\sigma$ ; scales honey-coloured to medium brown, to over 20-seriate at the broadened base but usually narrower, to  $3\frac{1}{2}$  by 1 mm. *Petioles* to 5 cm long but usually much shorter, less than 1 cm. *Lamina* 20 by 2 to 70 by 6 cm, with c. 40-80 pinnules to a side, rather suddenly, shortly, and strongly narrowed at both ends. *Pinnules* sessile, spreading, or slightly ascending or the basal ones somewhat falcately decurved, 15 by 4 to 28 by 8 mm, 3-4 times as long as wide, rarely less. Margins little convex except if pinnules falcate, the outer margin rounded, subtruncate, or virtually absent. Colour mostly dark green when dry. Incisions of upper/outer margin  $\frac{1}{3}$  to  $1\frac{1}{2}$  mm deep, occasionally deeper, mostly progressively deeper from base to apex, reaching almost to the level of the receptacle to considerably beyond; lobes regular, rounded or narrowed-rounded, often 1 mm wide. *Basal pinnules* reduced, often decurved, sterile, not rarely deeply pinnatifid. Veins single or rarely paired in the lobes. *Sori* on one, or on two connivent vein-ends (rarely a few on two more divergent vein-ends, then more elongate and the lobe subtruncate), roundish, distinctly intramarginal even in more deeply incised pinnules; indusium with concave base, reniform or subhippocrepiform, pale, entire, 0.4-0.8 mm long, 0.2-0.3 mm wide, not reaching the extremity of its lobe by its own width or more.

*Distr. Malesia:* Borneo (Sabah: Mt Kinabalu), Philippines (Palawan), Celebes, S. Moluccas, Aru and Kei Is., New Guinea, Admiralty Is., Solomon Is., Santa Cruz Is.; Western Polynesia.

*Ecol.* On trees, rarely epilithic, in moist forests, from sea-level up to c. 1800 m.

*Note.* The specimens from Mt Kinabalu have relatively shorter, less incised pinnules. In the W. part of its range there are some transitions to *var. pectinata*; there is probably some hybridization.

2. *var. delicatula* (CHRIST) KRAMER, Blumea 15 (1968) 569.—*Davallia delicatula* CHRIST.—*L. sagincola* WAGNER & GRETHOR.

*Rhizome* slender, c.  $\frac{1}{3}$ - $\frac{3}{4}$  mm  $\sigma$ ; scales honey-coloured, to 4 by  $\frac{1}{2}$  mm, to c. 16-seriate at the

base. *Petioles* to  $1\frac{1}{2}$  cm long, brownish and pale-angled. *Lamina* c. 12-25 by 2-3 cm, with up to c. 27 pinnules to a side; rachis adaxially shallowly grooved. *Pinnules* spreading or slightly ascending, mostly pale green when dry, the larger ones 12 by 5 to 15 by 7 mm, 2-3 times as long as wide, narrowed from the base to the narrowed-rounded or subacute apex; upper and lower margins almost straight, a distinct outer margin not developed. Upper margin crenately incised, the lobes rounded, often with irregular margin, mostly broader than long; incisions 5-6 per pinnule,  $\frac{1}{2}$ -1 mm deep, rarely deeper, reaching to the level of the receptacle or beyond. Veins lax, once forked or simple. *Sori* uni- or binerval, roundish to oblong; indusium pale, entire,  $\frac{1}{2}$ - $2\frac{1}{2}$  mm long, c. 0.4 mm wide, not reaching the margin by its width or more.

*Distr. Malesia:* Celebes, Territory of New Guinea, Admiralty Is. (Manus, Los Negros), New Ireland; 1 coll. from each locality, 2 from New Guinea.

*Ecol.* Epiphytic on sago palms, in swamps at sea-level.

3. *var. pectinata* (BLUME) METT. ex KUHN in Miq. Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 277.—*L. pectinata* BLUME.—*L. hymenophylloides* BLUME.—*L. bantamensis* BLUME.—*L. boryana* (PRESL) BRAUSE.—*L. pectinata* BLUME f. *dimorpha* ROSENSTOCK.—*L. repens* BLUME f. *truncatiloba* ROSENSTOCK.—*L. repens* BLUME var. *hemiptera* (BORY) v.A.v.R.—*L. repens* BLUME var. *intermedia* CHRIST.—*L. macraeana* (HOOKER & ARNOTT) COPELAND of HOLTUM, Rev. Fl. Mal. 2 (1954) 324; COPELAND, Fern Fl. Philip. 1 (1958) 101, etc., at least in part.—Fig. 43.

*Rhizome*  $1\frac{1}{2}$ - $2\frac{1}{2}$ , mostly 2 mm  $\sigma$ , eventually dark brown and devoid of scales; scales medium brown, to  $3\frac{1}{2}$  by  $\frac{1}{2}$  mm, to 16-seriate at the base. *Petiole* usually 2-5, sometimes up to 8 cm long. *Lamina* c. 30-80 by  $2\frac{1}{2}$ -5 cm; rachis usually adaxially sulcate only near the apex. *Pinnules* c. 40-100 to a side, spreading or, especially the basal ones, falcately decurved, less often somewhat ascending, variable in shape, subtrapezoidal, decurved-ligulate, or  $\frac{1}{4}$ -elliptic, the apex broadly rounded, subtruncate, narrowed-rounded, or subacute, usually the lower margin almost straight and the lower outward increasingly convex, but sometimes the opposite, occasionally chartaceous; larger pinnules 12 by 5 to 27 by 9 mm,  $2\frac{1}{2}$ -3 times as long as wide, but mostly less than 3 times. Upper/outer margin with up to 12 incisions, these to 1 mm deep, the inner ones shallow, reaching at the most to the level of the receptacle, the outer ones deeper; or sometimes the pinnules with only vestigial or rarely without any incisions. Lobes truncate, even most or all small ones, their margin sometimes a little irregular. *Sori* straight, bi- to plurinerval, interrupted by the incisions of the margin, even interrupted if these do not reach their level, or in entire pinnules, but seemingly confluent with age if the interruptions are short. Indusium entire or

sinuate, 0.3–0.5 mm wide, not reaching the margin by a little more than its width to almost reaching it, strongly reflexed and often quite concealed at maturity.

Distr. Assam, Ceylon, Thailand, Indo-China, in *Malesia*: Malay Peninsula, widespread and often common on the Greater Sunda Is., Mentawai Is., Bawean, Philippines.

Ecol. Epiphytic in moist forests, 600–1500 m, sporadically to sea-level.

Note. In Mindanao, Luzon, and Leyte an aberrant form is found, with little or not incised pinnules 9 by 5 to 15 by 8 mm, 2 to less than 1½ times as long as wide. It may be distinguished as *f. angusta* (COPELAND) KRAMER, *Blumea* 15 (1968) 568 (*L. angusta* COPELAND).

4. *var. submarginalis* KRAMER, *Blumea* 15 (1968) 569.—Type: BARTLETT 6603, Karo Plateau, Sumatra (L; dupl. in GH, MICH).—Fig. 44.

*Rhizome* scales to 3½ by ½ mm, medium brown, to c. 16-seriate at base. *Lamina* often basally little reduced, with a well-developed petiole of several cm. *Pinnules* often ascending and falcately upcurved, narrowed-rounded or subacute at apex, without an outer margin, the largest 20 by 5 to 26 by 6 mm, c. 3½ to over 4 times as long as wide, mostly dark when dry. Upper margin shallowly and regularly incised, the incisions to ½ mm deep, up to twice the distance from margin to receptacle; lobes truncate, the smaller ones truncate-rounded. *Sori* bi- to quadrinerval, straight with concave extremities or the shorter ones basally quite concave. Indusium entire, c. 0.3 mm wide, practically equaling the margin, strongly reflexed and quite concealed at maturity.

Distr. *Malesia*: Sumatra (7 coll.; some doubtful ones).

Ecol. Epiphytic in mountain forests, c. 1200–1800 m.

Note. Not quite sharply distinct from *var. pectinata*.

5. *var. pseudohemiptera* v.A.v.R. Bull. Jard. Bot. Btzg III, 2 (1920) 157, f. C.—Lectotype: BUNEMEIJER 5419, Mt Merapi, Sumatra (BO; dupl. in L, SING, U, US).

*Rhizome* dark, 1½–2 mm ø; scales medium to rather dark brown, to 2½ mm long, to c. 13-seriate at base. *Petioles* a few cm or up to 10 (exceptionally to 15) cm long. *Lamina* c. 30–50 by 3–4 cm, with c. 40–70 pinnules to a side. *Pinnules* spreading, slightly ascending or slightly decurved, often trapezoidal, narrowed to the apex or not, then subacute to truncate, mostly very dark when dry, the larger ones 20 by 5 to 30 by 6 mm, 3½ to over 5 times as long as wide; incisions of upper/outer margin rather regular, shallow, c. ½ mm deep, or, especially towards the apex of the pinnules, deeper, oblique, to 4 mm deep and then irregular and reaching to the middle of the pinnule, the pinnule-apex then sometimes protracted, with 1 or more pinnatifid prolongations. Lobes ligulate, narrowed-rounded, uni-

quadrinerval, with rather broad sinuses. Veins rather irregularly spaced. *Sori* uni- to quadrinerval, often on strongly connivent vein-ends, nearly marginal; indusium c. ½–2 mm long, 0.2 mm wide, pale, subentire, with concave base, not reaching the margin by its width or less, strongly reflexed and usually entirely concealed at maturity by the sporangia that spread in all directions, mostly somewhat beyond the edges of the soral lobes.

Distr. *Malesia*: Sumatra, Borneo (Sabah: Mt Kinabalu, etc.).

Ecol. Epiphytic in mountain forests, 1500–1800 m.

Notes. Several juvenile plants from N. Borneo with rigid bipinnatifid pinnules may belong to this variety.

The very irregularly and deeply cleft pinnules, as described and figured by VAN ALDERWERELT VAN ROSENBURGH, occur in the two syntypes and some other specimens, but usually the incisions are much less deep and more regular.

This variety may be a distinct species; the scales are darker than in the other varieties.

47. *Lindsaea apoensis* COPELAND in Perkins, *Fragm. Fl. Philip.* (1904) 182, pl. 4 f. A; Fern Fl. Philip. 1 (1958) 103.—Type: COPELAND 1181, Mt Apo, Mindanao (n.v.); paratype: DE VORE & HOOVER 365 (dupl. in K, S-PA).

*L. havicei* COPELAND, *Philip. J. Sc.* 1 (1906) Suppl. II, 149; Fern Fl. Philip. 1 (1958) 103.—Type: COPELAND 1758, Mt Balabac, Mindanao (MICH; dupl. in B, P).—Fig. 50.

*Rhizome* long-scandent, brown, 1–1½ mm ø; scales deciduous, dorsally more persistent, golden-brown, to c. 2½ mm long, elongate-ovate, to c. 20-seriate at base, with a very short uniseriate apex. Leaves 1–3 cm apart, issuing at a small angle but usually curved to right angles with the rhizome; *petioles* stramineous to pale brown, rarely darker and then pale-margined, quadrangular, laterally ± sulcate, 5–20 cm long, shorter than the lamina. *Lamina* linear, 20–40 cm long, 3–6½ cm wide, shortly to very shortly acuminate, shortly narrowed or more often abrupt at the base, with 20–50 pinnules to a side; rachis stramineous, adaxially shallowly sulcate, or flat at the base. Some basal pinnules inserted below the edges of the adaxial face of the rachis, spreading or slightly ascending, rather variable in shape, narrowly triangular to subtrapezoidal, narrowed from base to apex and acute or less narrowed and with truncate apex, the apex occasionally caudate-protracted; texture herbaceous, colour medium to dark green when dry. *Larger pinnules* 2–3 cm long, 4–7 mm wide, 4–5 times as long as wide; lower margin mostly at least at the base concave, upper margin straight or ± convex, with c. 6–8 major incisions, these slightly oblique, almost parallel, towards the apex of the pinnule progressively deeper, the inner ones 1–2 mm deep, reaching to ¼–⅓ (rarely deeper and reaching beyond the middle), the outer ones at least 2 mm deep, reaching to the middle or far beyond; inner lobes often more shallowly incised again;

lobes little narrowed, almost parallel-sided, rounded at apex, uni- or binerval. Pinnule-apex sometimes protracted into a pinnatifid cauda. *Lower pinnules* not remote and reduced or very few more remote and/or slightly reduced; some upper pinnules gradually reduced, confluent into a pinnatifid leaf-apex. *Juvenile plants* without the deeply incised pinnules found in *L. repens*. Veins immersed, evident, once or twice forked, or the outer ones simple. *Sori* bi- or more often uninerval; indusium entire, if binerval elongate and with concave base, if uninerval reniform to hippocrepiform,  $\frac{1}{2}$ –1 mm long, 0.6 mm wide, falling short of the margin by  $\frac{1}{2}$ –1 times its width, strongly reflexed, often shrivelled and not visible at maturity. Spores pale yellowish, hyaline, trilete, smooth, *c.* 23  $\mu$ .

Distr. *Malesia*: Philippines (Luzon, Negros, Leyte, Mindanao).

Ecol. Epiphytic in moist mountain forests, 1200–2100 m.

Note. The basally truncate or almost truncate lamina and the pinnules incised to the middle at least near the apex are distinctive.

**48. *Lindsaea merrillii* COPELAND** in Perkins, *Fragm. Fl. Philip.* (1904) 181; TAGAWA, *Act. Phytotax. Geobot.* 6 (1937) 33, f. 2 E, F; COPELAND, *Fern Fl. Philip.* 1 (1958) 102.—Type: MERRILL 1774, Baco R., Mindoro (MICH; dupl. in B, GH, K, US).

*Odontoloma repens* auct. non (BORY) PRESL; J. SMITH, *Hist. Fil.* (1875) pl. 18 d.—Fig. 42.

*Rhizome* long-scandent, dark brown, 1–2 mm  $\sigma$ ; scales deciduous, dorsally more persistent, lemon-coloured to light brown, elongate-triangular, to  $3\frac{1}{2}$  by 1 mm, up to *c.* 20-seriate at base, with a very short uniseriate apex. Leaves 1–4 cm apart; *petioles* virtually absent to 8 cm long, stramineous with dark base or brown and then often pale-angled, quadrangular, only if very short sometimes subterete, very much shorter than the lamina. *Lamina* linear, 25–50 cm long, 2.5–4.2 cm wide, moderately to strongly narrowed at base, acuminate, with *c.* 35–60 pinnules to a side; rachis stramineous, sharply quadrangular, adaxially flat or shallowly sulcate, abaxially usually flat. *Pinnules* spreading or somewhat ascending, elongate-triangular or less often semi-ovate, herbaceous, medium to dark green when dry, the larger ones 11–22 mm long, 4–6 mm wide, 2–4 $\frac{1}{2}$  times as long as wide, narrowed from base to apex, the apex subacute or less often narrowed-rounded or rounded; lower margin straight, outward convex; upper margin approximately straight, regularly dentate if sterile, more irregularly crenate or dentate if fertile, the incisions  $\frac{1}{2}$ –1 mm deep, not reaching down to the middle except sometimes near the apex; teeth narrowed from base to apex, acute if sterile, obtuse and erose to acute and often very irregularly erose if fertile, the middle more protruding. *Basal pinnules* reduced and remote, often auriculiform and a few mm long, sterile; *upper pinnules* gradually and

strongly reduced, confluent into a pinnatifid leaf-apex. Veins immersed, evident, once forked, less often twice forked or simple, 1 or 2 running to each lobe, their ends *c.* 1 mm apart. *Sori* uni- or binerval, single on the teeth; indusium pale, subentire, semicircular or reniform to oblong,  $\frac{1}{2}$ –1 mm long, *c.* 0.3 mm wide, with convex to slightly concave base, not reaching the margin by about its width or more,  $\pm$  reflexed and sometimes concealed at maturity. Spores pale brown, trilete, smooth, *c.* 22  $\mu$ . Juvenile plants have deeply divided pinnules, but less regularly so than in *L. repens*.

Distr. *Malesia*: Philippines (Samar, Polillo, Batanes, Leyte, Camiguin, Mindanao, Mindoro, Luzon); these plants belong to *ssp. merrillii*. Another subspecies in the Ryu Kyu Is. and Taiwan.

Ecol. Epiphytic on palms and other trees, from sea-level up to 700 m.

Note. *Davallia boryana* PRESL was described from a specimen from Sorzogon belonging to this species; but PRESL cited *Dicksonia repens* as a synonym, and *D. boryana* must therefore be regarded as a new name for that species.

**49. *Lindsaea carvifolia* KRAMER**, *Blumea* 15 (1968) 569.—Type: BEGUIN 1116, Ternate (BO; dupl. in L).—Fig. 48.

*Rhizome* long-scandent, brown, 1–2 mm  $\sigma$ , deciduously scaly; scales honey- to fawn-coloured, narrowly triangular, to 2 mm long, to *c.* 16-seriate at the base, scarcely uniseriate at the apex. Leaves remote, *c.* 1–5 cm apart; *petioles* stramineous, or with brown base, adaxially flattened or sulcate, abaxially convex, rounded to obtusely bi-angular, extremely short to 4 cm long. *Lamina* linear, 20–50 cm long,  $1\frac{1}{2}$ –4 cm wide, tapering at both ends, with *c.* 50–80 pinnules to a side; rachis adaxially flattened or sulcate, abaxially bi-angular to broadly and shallowly sulcate. *Pinnules* herbaceous to chartaceous, dark green when dry, spreading or somewhat ascending, at least in the basal part of the lamina inserted somewhat below the level of the adaxial rachis face, often more remote in the lower part of the lamina, the larger ones 6 by 2 to 20 by 6 mm, 3 times as long as wide, almost evenly narrowed from base to apex, subtriangular; upper margin deeply incised, the primary segments 5–7, all but the smallest once, the largest twice bifid; lobes little divergent, linear to capillary, (0.3–) 0.5–1 mm wide, often seemingly narrower when dry because of the revolute margins, sometimes somewhat broadened at the sorus, the apex rounded; wing connecting the primary segments *c.*  $\frac{1}{4}$  mm wide at the narrowest points. Veins immersed, evident, single, rarely paired in larger, scarcely bifid lobes. *Sori* uninerval or very rarely binerval, one per ultimate lobe, mostly roundish; indusium pale, with straight or concave base, flattened-elliptic to hippocrepiform, 0.3–0.5(–0.7) mm long, *c.* 0.2 mm wide, almost reaching the margin to not reaching it by more than its width, reflexed and  $\pm$  concealed at maturity, the spo-



Fig. 48. *Lindsaea carvifolia* KRAMER. Two laminas,  $\times \frac{2}{5}$  (ANDERSON S 20179).—Fig. 49. *L. glandulifera* v.A.v.R. Leaf,  $\times \frac{2}{5}$  (VAN HEURN 196).—Fig. 50. *L. apoensis* COPEL. Lamina,  $\times \frac{2}{5}$  (EDAÑO 5229).

rangia often spreading beyond the edges of the segment. Spores pale brown, trilete, smooth, c. 25  $\mu$ .

Distr. *Malesia*: Borneo, Celebes (?), Moluccas (Morotai, Halmahera, Ternate).

Ecol. Epiphytic or rarely terrestrial, in mountain forests, 500–1700 m.

Note. The single collection from Celebes (WARBURG 16527, B) may belong to *L. rosenstockii*, but the occurrence of that species in Celebes is unlikely.

**50. *Lindsaea fissa*** COPELAND, Philip. J. Sc. 38 (1929) 143, pl. 1; Fern Fl. Philip. 1 (1958) 105.—Type: MERRILL 9527, Mt Capoas, Palawan (MICH; dupl. in BM, BRI, GH, L, P, US).

*L. hymenophylloides* auct. non BLUME; COPELAND, Fern Fl. Philip. 1 (1958) 105.—Fig. 47.

*Rhizome* long-scandent,  $\frac{3}{4}$ –2 mm  $\phi$ , dark brown, deciduously scaly; scales dorsally more persistent, golden brown to fawn-coloured, triangular, to 3 by 1 mm, to c. 22-seriate at the base, there the cell partitions sometimes bulging beyond the margin, the apex very shortly uniseriate. Leaves rather remote,  $\frac{1}{2}$ –4 cm apart; *petioles* dark or reddish brown, or paler above, abaxially terete at the base, upward gradually bi-angular, laterally often sulcate, adaxially flattened to shallowly sulcate, 1–5(–10) cm long, much shorter than the lamina. *Lamina* linear, tapering at both ends, (10–)15–40 cm long, (1½–)2–3 cm wide, with c. 20–60 pinnules to a side; rachis stramineous, quadrangular, adaxially at least upward sulcate. *Pinnules* thinly herbaceous, dark green to olivaceous or blackish when dry, spreading or falcately deflexed, rarely ascending, rather close or contiguous, approximately ¼-elliptic in outline, the larger ones (7–)10–15 by 3–5 mm, 2–3 times as long as wide; upper margin outward gradually more convex, deeply incised, larger pinnules consisting of 4–5 primary segments, the inner, larger ones usually forked (occasionally twice forked); ultimate segments divergent, linear-cuneate, ½–2 mm wide at the apex, narrowed just below the sorus, little or not narrowed to the base, there connected by wings of ¼–½ mm; apex of segments truncate-sinuate or -erose, not rarely with two slightly larger lateral protuberances, sometimes also with 1–2 smaller ones between them. Few upper pinnules reduced and confluent into a pinnatifid leaf-apex; some to many basal ones remote and gradually reduced, usually inserted just below the lateral ridges of the adaxial rachis face. Veins immersed, evident, single or paired in the ultimate lobes. *Sori* uni- or not rarely binerval; indusium thin, pale to brown, subentire, ½–2 mm long, 0.4 mm wide, at least laterally convex at the base, not reaching the margin by about its width to almost reaching it, not reflexed at maturity. Spores very pale brown, trilete, smooth, c. 25  $\mu$ .

Spores very pale brown, trilete, smooth, c. 25  $\mu$ .

Distr. *Malesia*: Philippines (Luzon, Palawan, Panay, Negros, Mindoro, Biliran, Mindanao).

Ecol. Epiphytic in humid mountain forests, 860–1400 m; few ecological notes given.

**51. *Lindsaea capillacea*** CHRIST, Bull. Herb. Boiss. 1, 6 (1898) 144, pl. 4 f. 7; COPELAND, Fern Fl. Philip. 1 (1958) 106.—Type: LOHER s.n., Mt Maquiling, Luzon (P; dupl. in B, K, S-PA).—Fig. 46.

*Rhizome* long-scandent, dark brown, ½ mm  $\phi$ , deciduously scaly; scales golden brown, narrowly triangular, to 1¼ mm long, up to 9-seriate at base, scarcely uniseriate at apex. Leaves 1–2 cm apart; *petioles* dark brown, lustrous, adaxially flattened or sulcate, abaxially terete at base, obtusely or acutely bi-angular above, 1–5 cm long, much shorter than the lamina. *Lamina* linear, 4–15 cm long, 1–2½ cm wide, narrowed at both ends; rachis brown at the base, upward stramineous, adaxially often quite stramineous, at least above sulcate, abaxially bi-angular. *Pinnules* c. 15–60 to a side, thinly herbaceous, dark green when dry, spreading or slightly ascending or the basal ones deflexed, the larger ones 4–15 mm long, 2–4 mm wide, 2 to almost 4 times as long as wide, ¼-elliptic to almost triangular in outline, the upper margin straight or more often outward increasingly convex, deeply incised; larger pinnules with 2–5 primary lobes, the largest one or two forked; segments 0.4–0.8 mm wide near the apex, narrowed to the base, there about half as wide, joined by wings of 0.1–0.3 mm,  $\pm$  divergent; fertile segments at the apex bi-apiculate, with two lateral horn-like projections of 0.3–0.4 mm, the margin between them subentire, erose, or with similar but shorter projections. *Upper pinnules* reduced, confluent into a pinnatifid leaf-apex; *lower pinnules* more remote, scarcely to rather strongly reduced. Veins immersed, evident, single in the lobes. *Sori* strictly uninerval; indusium pale, brownish, subentire, ¼–1 mm long, ¼ mm wide, with straight or slightly concave, laterally convex base, not quite reaching the margin, scarcely reflexed at maturity. Spores pale brown, trilete, smooth, c. 25  $\mu$ .

Distr. *Malesia*: Philippines (Luzon, c. 25 coll.).

Ecol. Epiphytic or occasionally terrestrial, in moist mountain forests, 600–2200 m.

Note. This might be taken for a small form of *L. fissa*, and small specimens of that species may resemble *L. capillacea*, but they lack the well-developed latero-apical horns of the segments. The fact that in Luzon the two species occur together shows that they are not geographical variants.

11. Section *Pseudolancea*

KRAMER, *Blumea* 15 (1968) 563.

Type and sole species: *Vittaria parasitica* ROXB. ex GRIFF. = *L. parasitica* (ROXB. HIERON.

*L. parasitica* is probably related to *L. oblanceolata* in sect. *Odontoloma*. But *L. parasitica* has bipinnate fronds on fully developed plants, whereas the fronds of all species of sect. *Odontoloma* are simply pinnate; the separation of *L. parasitica* thus leaves a more clearly natural sect. *Odontoloma*. It seems probable that the bipinnate condition has arisen on more than one evolutionary line within subg. *Odontoloma*; this subject will be further discussed elsewhere.

**52. *Lindsaea parasitica*** (ROXBURGH ex GRIFFITH) HIERON. *Hedwigia* 62 (1920) 14; KRAMER, *Blumea* 15 (1968) 570.—*Vittaria parasitica* ROXBURGH ex GRIFFITH, *Calc. J. Nat. Hist.* 4 (1844) 510.—Type: ROXBURGH s.n., Prince of Wales' Island (Penang) (n.v.).

*L. scandens* HOOKER, *Sp. Fil.* 1 (1846) 205, pl. 63 B; BEDD. *Ferns Brit. Ind.* 2 (1868) pl. 298; HOLTUM, *Rev. Fl. Mal.* 2 (1954) 325, f. 186; COPELAND, *Fern Fl. Philip.* 1 (1958) 105.—Lectotype: CUMING 405, Luzon (K).

*L. lancea auct. non* (L.) BEDD. of various authors, as to Asiatic specimens, in part.

*Rhizome* long-scandent, often knotted, fuscous, 2–3 mm  $\phi$ ; scales castaneous, to 4 by 1 mm, triangular, to c. 25-seriate at base, the uniseriate apex very short. Leaves one to many cm apart; *petioles* stramineous or with dark base, stout, up to 3 mm  $\phi$  at base, adaxially with a very narrow groove across which its borders often touch, abaxially terete, c. 7–30 cm long in bipinnate leaves, much shorter than the lamina, almost wanting to c. 5 cm long in simply pinnate leaves. *Lamina* simply pinnate or bipinnate; if simply pinnate c. 20–35 cm long, 2½–5 cm wide, very narrowly oblong, gradually narrowed at base, shortly and abruptly narrowed at apex; if bipinnate c. 35–50 cm long, c. 20–35 cm wide, oblong, c. 1½ times as long as wide, not narrowed at base, with 1–6 primary pinnae to a side and a conform terminal one; primary rachis of bipinnate leaves similar to the petiole but the adaxial groove mostly more open, with flat or convex bottom. *Primary pinnae* ascending or spreading, usually alternate, remote, up to 8 cm apart, sessile, 15–25 by 2–5 cm, acute to shortly acuminate, with c. 20–35 pinnules to a side; simply pinnate laminae similar but narrowed at the base, usually longer and less narrowed at the apex. Pinnule-bearing rachises abaxially terete, adaxially laterally sharply marginate, with a convex-bottomed groove. *Pinnules* firmly herbaceous, drying medium to dark green or blackish, described as glossy by some collectors, close, regularly spaced, usually contiguous,

spreading or slightly ascending, the basal ones sometimes deflexed, dimidiate-elliptic to ligulate or slightly subfalcately decurved, little or not narrowed to the apex, apically  $\pm$  rounded, a separate outer margin not developed, sometimes an angle between lower and outer part of upper margin; larger pinnules 11 by 6 to 20 by 8 mm, 2–2½ times as long as wide. Margins entire, shallowly crenate in sterile pinnules, more deeply crenate in juvenile plants. Very few *upper pinnules* reduced in simply pinnate leaves, more numerous and more strongly reduced in bipinnate ones, none or 1 or 2 connected with the asymmetrically triangular to broadly lanceolate terminal pinnule (segment). Veins immersed, usually evident, often visible as striations, free, mostly twice forked. *Sori* continuous, occupying all vein-ends; indusium pale, entire, 0.3–0.4 mm wide, not reaching the margin by less than its width to nearly reaching it, strongly reflexed and often concealed at maturity. Spores yellowish, trilete, smooth, c. 22  $\mu$ .

Distr. Peninsular Thailand; *Malesia*: Malay Peninsula, Singapore, Sumatra, Borneo.

Ecol. Epiphytic or occasionally terrestrial, from sea-level up to c. 1100 m.

Notes. The lectotype of *L. scandens*, CUMING 405, was said to have come from Luzon; a synonym is labelled 'Leyte'. The identity of the latter is doubtful; and as *L. parasitica* is not otherwise known from the Philippines it seems more likely that CUMING's plant, like others of his collection, was mislabelled and came actually from the Malay Peninsula.

Simply pinnate specimens of *L. parasitica* may be very similar to *L. oblanceolata*; the two are probably related. In *L. oblanceolata* the basal pinnules are inserted below the adaxial face of the rachis, in *L. parasitica* they are borne on the edges of the rachis groove.

Another species with strikingly similar foliage but different rhizome and scales is 32. *L. doryphora*. For additional characters serving to distinguish detached leaves see under that species.

12. Section *Lindsaenium*

(FÉE) KRAMER, *Blumea* 15 (1968) 563.—*Lindsaenium* (or *Lindsaynium*) FÉE, *Mém. Soc. Mus. Hist. Nat. Strasb.* 4 (1850) 201; *Gen. Fil.* (1852) 333.

Type species: *Lindsaea rigida* J. SMITH in Hooker.

Distr. Malay Peninsula to Micronesia and Tahiti; all species occur in Malesia.

Taxon. A very natural group of epiphytic species with long-creeping rhizomes, at least some bipinnate leaves, and interrupted sori. The first four and the last three species are more closely inter-related.

**53. *Lindsaea rigida*** J. SMITH in Hooker, Sp. Fil. 1 (1846) 217, pl. 63 A; HOLTUM, Gard. Bull. S. S. 5 (1930) 65; COPELAND, Philip. J. Sc. 78 (1949) 19; HOLTUM, Rev. Fl. Mal. 2 (1954) 330; KRAMER, Blumea 15 (1968) 570.—*Lindsaenium rigidum* (J. SMITH) FÉE, Mém. Soc. Mus. Hist. Nat. Strasb. 4 (1850) 201; Gen. Fil. (1852) 333, pl. 27 bis.—Lectotype: LOBB s.n., Mt Ophir, Johore ('Malacca') (K, 2 sh.; dupl. in E).

*L. longissima* CHRIST, Ann. Jard. Bot. Btzg II, 5 (1905) 131.—Type: JAHERI (exp. NIEUWENHUIS) 958, Lelibulan Teputsy, Kalimantan, Borneo (P; dupl. in BO).

*L. monosora* COPELAND in Elmer, Leafl. Philip. Bot. 2 (1908) 398; Fern Fl. Philip. 1 (1958) 109; non ROSENSTOCK (1912).—Type: ELMER 10077, Cuernos, Negros (MICH; dupl. in B, BM, BO, BRI, E, GH, HBG, K, L, P, U, US, W, Z).

*L. diplosora* v.A.V.R. Bull. Jard. Bot. Btzg II, 16 (1914) 21.—Type: MATTHEW, 523, Mt Singalang, Sumatra (BO; dupl. in K).

*L. triplosora* v.A.V.R. Bull. Jard. Bot. Btzg II, 16 (1914) 21.—Type: MATTHEW 686, Mt Sago, Sumatra (BO; dupl. in K).

*L. rigida* J. SMITH f. *acutata* v.A.V.R. Handb. Suppl. (1917) 210.—Type: not designated; no specimen so annotated seen from BO.

*L. sepikensis* BRAUSE, Bot. Jahrb. 56 (1920) 131; COPELAND, Philip. J. Sc. 78 (1949) 22.—Type: LEDERMANN 9423 p.p., Etappenberg, Sepik R. region, Terr. of New Guinea (B; dupl. in BM).

*L. diplosora* v.A.V.R. var. *acrosora* C. CHR. Gard. Bull. S. S. 7 (1934) 235.—Type: Mjöberg 94, Mt Tibang, Sarawak (BM; dupl. in S-PA).

*Rhizome* long-scandent,  $1\frac{1}{2}$ –3 mm  $\phi$ ; scales golden brown, narrowly triangular, to 3 by  $\frac{1}{2}$  mm, to c. 10-seriate at base, with a short uniseriate apex. Leaves usually  $2\frac{1}{2}$  cm or more apart, rarely closer; *petioles* issuing almost at right angles from the rhizome, olivaceous to dark brown, often with elongate, paler protuberances, abaxially terete, adaxially at least above flattened to sulcate, 10–40 cm long, about equaling to much longer than the lamina. *Lamina* oblong, 20–50 cm long, bipinnate, with 1–7 pairs of usually subopposite pinnae and a conform terminal one; primary rachis abaxially terete or upward obtusely bi-angular, adaxially broadly and shallowly sulcate, with obtuse lateral ridges. *Pinnae* not close, often 6–8 cm apart, ascending, linear, sessile, 10–25 cm long, 10–20 mm wide, gradually tapering from the lower third or the middle upward; *secondary rachises* brown, abaxially sharply bi-angular except for a short terete basal portion, the angles often paler, the face between them flat or concave. Upper pinnae of plurijugate leaves slightly shortened. *Pinnules* herbaceous to rigidly coriaceous, mostly dark olivaceous to blackish when dry, usually spreading, c. 25–45 to a side, their width apart or less but not contiguous, subtrapeziform, obliquely ovate, or  $\frac{1}{4}$ -elliptic, the larger ones 7 by 3 to 12 by 6 mm, mostly twice (to  $2\frac{1}{2}$  times) as long as wide, narrowed (sometimes very little) from base to apex; *margins* pale-sclerotic, especially in rigid pinnules; lower

margin straight or distally convex, upper margin distally gradually convex, a distinct outer margin usually not developed. Upper margin of sterile pinnules (bi)crenate to dentate, of fertile pinnules crenate with incisions to 1 mm deep, less in rigid pinnules, the lobes subtruncate. Veins immersed and evident in herbaceous,  $\pm$  elevated on both sides in rigid pinnules, simple or once, rarely twice, forked, free, connivent, or with one anastomosis between upper and lower margin, the anastomoses irregular, often involving only part of the veins and mostly not found in all pinnules.

*Upper pinnules* very gradually and strongly reduced, some denticuliform ones confluent into a narrow, lobed pinna-apex. *Sori* 1–4 per pinnule, 1 per lobe, on the outer lobes; larger pinnules only partly soriferous, the inner part of the upper margin sterile; very often only the outermost sorus present, on 2–6 veins, to 5 mm long; inner sori shorter. Receptacle straight or with convex ends; indusium mostly rigid, brownish, subterete to erose, narrowed at the adnate ends,  $\frac{1}{2}$ – $\frac{3}{4}$  mm wide, not quite reaching the margin, reflexed or not at maturity. Spores dark brown, trilete, slightly pustulate, c. 25  $\mu$ .

*Distr. Malesia:* Malay Peninsula, Sumatra, Borneo, Celebes, Philippines (Palawan, Negros, ?Luzon), Moluccas (Batjan), Japan, New Guinea; Ponape; Solomon Is.; Tahiti.

Specimens labelled 'New Hebrides' possibly, 'Singapore' and 'Java' probably from elsewhere.

*Ecol.* Epiphytic or epilithic, or terrestrial, among mosses, not high above the ground (according to HOLTUM); 1000–2000 m, rarely lower. The most rigid specimens are from higher altitude in Malaya, Sumatra, and New Guinea.

*Note.* In spite of a certain variability this is a distinctive species, and it is surprising that it has comparatively many synonyms and is often misidentified.

**54. *Lindsaea monocarpa*** ROSENSTOCK in C. Chr. Ind. Fil. Suppl. 1 (1913) 49, based on: *L. monosora* ROSENSTOCK, Nova Guinea 8 (1912) 720, non COPELAND (1908).—Lectotype: VON RÖMER 785, Hellwig Mts, W. New Guinea (L; dupl. in BO).

In most respects like the rigid, little incised form of *L. rigida*. *Petiole*, primary, and *secondary rachises* dark castaneous, *abaxially quite terete*. Pinnules subtrapezoidal, the larger ones 10 by 4 mm, very shallowly crenate; veins almost hidden, occasionally connivent or anastomosing; pinnules with a single apical sorus.

*Distr.* Both syntypes, VON RÖMER 785 and 1163a, from the same locality.

*Ecol.* No data.

*Note.* Perhaps only a form of *L. rigida*; but that species is so constant in the characters of its axes that in the absence of transitions *L. monocarpa* is better retained as a species.

**55. *Lindsaea sarawakensis*** KRAMER, Blumea 15 (1968) 570.—Type: Mjöberg 9, Mt Murud, Sarawak (P, 3 sh.).

*Rhizome* unknown. *Petioles* dark brown, shining, abaxially rounded or upward obtusely bi-angular. *Lamina* c. 35–40 cm long, oblong, bipinnate, with 4–5 pinnae to a side and a conform terminal one; primary rachis dark brown, abaxially rounded or narrowed-rounded. *Pinnae* linear, 15–30 cm by 12–15 mm, acute, with c. 55–95 pinnules to a side; secondary rachises brown at base, otherwise stramineous, abaxially carinate almost to base. *Pinnules* herbaceous, subcontiguous, asymmetrically ligulate, narrowed-rounded, at apex, the larger ones about 7 by 2 to 2½ mm, the upper ones gradually and ± strongly reduced, a few confluent with the small lanceolate terminal segment. Upper margin of larger pinnules with 2 or 3 very oblique, acute incisions reaching down to ¼; lobes rounded. Veins immersed, not evident, free, simple or once forked. *Sori* only in the outer part of the upper margin (in fully fertile pinnules possibly more extensive), bi- or rarely uninervial; indusium brownish, c. 0.3 mm wide, not quite reaching the margin. Spores pale brown, trilete, smooth, c. 20 µ.

Distr. Only known from the type collection.

Ecol. No data.

Note. In the absence of a rhizome the taxonomic position of this species is not quite certain, but it resembles *L. rigida* in several characters.

**56. *Lindsaea regularis* ROSENSTOCK, Meded. Rijksherb. 14 (1912) 31.**—Type: ELBERT 1789, Mt Pussuk, Lombok, Lesser Sunda Is. (L; dupl. in BO, K, SING).—Fig. 52.

*Rhizome* long-scandent, 1½–2½ mm ø; scales deciduous, fawn-coloured, triangular-acuminate, to 4 by 2 mm, the base broadened, over 20-seriate, with often laterally projecting cell-walls, the apex shortly uniseriate. Leaves c. 2–10 cm apart; *petioles* medium brown, often scaly at the base, terete, or adaxially in the upper part flattened or subsulate, 10–25 cm long, about as long as the lamina. *Lamina* oblong, bipinnate (occasionally sterile simply pinnate ones also present), c. 15–30 cm long, with 3–9 pinnae to a side and a conform terminal one; primary rachis terete, adaxially with a distinct but shallow and very narrow groove that is usually not clearly continuous with the grooves of the lower pinnae and occasionally extends to the petiole. *Pinnae* ascending or upcurved, sessile, the lower ones several times their width apart, the upper ones closer, linear, c. 10–20 cm long, 11–16 mm wide, often widest near the middle, gradually and strongly narrowed in the upper ½ or ⅓; secondary rachises abaxially terete at the base, upward gradually bi-angular, then sulcate, or occasionally bi-angular to base, sometimes pale-angled. *Pinnules* c. 20–50 to a side, herbaceous, mostly dark olivaceous when dry, regularly spaced, mostly not contiguous, asymmetrically ovate to shortly ligulate, 6–10 by 3–4 mm, 2–2½ times as long as wide, slightly ascending, the lower margin almost straight, the upper margin distally convex, a distinct outer margin not developed, the pinnule-apex rounded or narrowed-rounded.

*Upper pinnules* gradually and strongly reduced, several denticuliform ones connected with the narrow, caudiform pinna-apex. *Margins* scarcely sclerotic; upper margin shallowly incised, with 3–5 incisions ¼–½ mm or even less deep, the lobes slightly convex to flat; sterile pinnules crenate to subentire. Veins immersed, evident, simple or once, less often twice forked, free. *Sori* interrupted, mostly 1 per lobe, even though most incisions do not reach to the receptacle, shorter than the lobes, often 3–5 per pinnule, uni- to quadrinervial; indusium pale, stiff, entire or nearly so, with straight base and narrowed adnate sides, ½ mm wide, almost or quite reaching the margin, little reflexed at maturity. Spores hyaline, trilete, smooth, c. 22–25 µ.

Distr. *Malesia*: East Java (2 coll.), Lesser Sunda Is. (Bali, Lombok, Flores, Timor).

Ecol. Epiphytic in primary forest, 600–1700 m, on trees and tree-ferns. Apparently uncommon.

**57. *Lindsaea microstegia* COPELAND, Philip. J. Sc. 6 (1911) Bot. 83; *ibid.* 78 (1949) 20.**—Type: KING 242, Papua (MICH).

*L. pectinata* BLUME var. *brevipinnula* ROSENSTOCK, Hedwigia 56 (1915) 351.—Type: BAMLER 126, Mt Sattelberg, Terr. of New Guinea (B; dupl. in P).—Fig. 41, 51.

*Rhizome* long-scandent, brown, 1–2 mm ø, the older parts loosely scaly; scales honey-coloured, triangular to lanceolate with concave base, there with ± protruding cell-walls, to 2 mm long, to c. 20-seriate at base, the apex scarcely or not uniseriate. Leaves not close, to c. 10 cm apart; *petioles* stramineous to medium brown, adaxially grooved, abaxially terete, or above obtusely bi-angular, 8–20 cm long, mostly shorter than the lamina. *Lamina* bipinnate, occasionally simply pinnate fertile leaves also present, rarely the whole plant with simply pinnate leaves, broadly oblong, 15–60 cm long, with 1–7 pinnae to a side and a conform, often very large terminal one; primary rachis stramineous, abaxially often ± pronouncedly bi-angular. *Pinnae* mostly little ascending, alternate or the basal ones subopposite, sessile, not close, 10–20 cm long, 1¾–3 cm wide, acuminate; secondary rachises abaxially bi-angular and flat or shallowly sulcate almost to base. *Pinnules* c. 20–25 to a side, herbaceous, medium to dark or olivaceous green when dry, regularly spaced, close, spreading, approximately trapezoidal or rarely subligulate or semi-ovate, the larger ones 10–15 by 5–7 mm, 2–2½ times as long as wide, mostly narrowed from base to apex, the apex narrowed-rounded or subtruncate, outer margin distinct or broadly rounded into the upper margin; upper/outer margin sinuate to shallowly crenate, the incisions less than 1 mm deep, not reaching to the level of the receptacle (rarely slightly beyond), the lobes very broadly rounded, 1½–2 mm wide. One or two basal pinnules slightly reduced; upper pinnules gradually and strongly reduced, some denticuliform ones confluent with the narrow, caudiform terminal segment, or rarely much less reduced. *Pinnules of juvenile plants*





Fig. 51. *Lindsaea microstegia* COPEL. Apex of plant,  $\times \frac{1}{3}$  (BRASS 25846).—Fig. 52. *L. regularis* ROSENSTOCK. Leaf,  $\times \frac{1}{3}$  (POSTHUMUS 3202).

deeply incised. Veins immersed, evident, mostly once forked, free except if loop-connected by the receptacle. *Sori* 4–12 per pinnule, on (1–)2 (–4) vein-ends; indusium ovate, transversely oblong to linear, 0.15–0.4 mm wide, not reaching the margin by  $1\frac{1}{2}$ –3 times its width, reflexed, concealed, often evanescent at maturity. Spores very pale, trilete, smooth, *c.* 25  $\mu$ .

Distr. *Malesia*: New Guinea (all Div.); d'Entrecasteaux Is.

Ecol. Epiphytic or rarely terrestrial, in moist forests, 80–2100 m.

Note. See after *L. versteegii*.

**58. *Lindsaea rosenstockii* BRAUSE, Bot. Jahrb. 56 (1920) 128.**—Lectotype: LEDERMANN 10030, Lordberg, Sepik R. region, Terr. of New Guinea (B, 3 sh.).—Fig. 40.

*Rhizome* long-scandent, brown,  $1\frac{1}{2}$ –2 mm  $\sigma$ ,  $\pm$  persistently scaly; scales honey-coloured, narrowly triangular or triangular-ovate, up to 3 by  $1\frac{1}{2}$  mm, up to *c.* 25-seriate at base, the apex scarcely or not uniseriate. Leaves remote,  $1\frac{1}{2}$ –15 cm apart, issuing at about right angles; *petioles* stramineous to pale brown or mottled, adaxially narrowly sulcate, abaxially terete or faintly bi-angular, short in simply pinnate leaves, 6–20 cm long in bipinnate ones, shorter than the lamina. *Lamina* simply pinnate or bipinnate; if bipinnate oblong, 15–50 cm long, with 2–13 (often 6) pinnae to a side and a conform terminal one; primary rachis abaxially subterete or mostly bi-angular and convex. *Pinnae* little ascending, their width apart or a little closer, sessile, linear, 8–15 cm long,  $1\frac{1}{2}$ –2 $\frac{1}{2}$  cm wide, shortly acuminate; simply pinnate laminae similar but mostly larger. Secondary rachises adaxially broadly sulcate, abaxially bi-angular almost to the base, the greater part narrowly sulcate and green-winged. *Pinnules* herbaceous, dark green when dry, *c.* 15–25 to a side, close, spreading, slightly ascending, or often slightly falcately decurved,  $\frac{1}{4}$ -ovate in outline, the larger 1–1 $\frac{3}{4}$  cm by 4–7 mm, mostly about  $2\frac{1}{2}$  times as long as wide; lower margin straight or concave, upper margin convex, a distinct outer margin not developed. *Pinnules* deeply incised from the upper margin, with 4 or 5 segments, the inner 1 or 2 bifid, or rarely twice bifid; *lobes*  $\frac{2}{3}$ –2 mm wide, at the sorus broadened, to  $1\frac{1}{2}$  mm wide, parallel-sided or slightly narrowed at the base, joined by a wing of  $\frac{1}{2}$  mm, subacute if sterile, rounded or sinuate-rounded if fertile. Upper pinnules rather suddenly reduced, confluent into a pinnatisect pinna-apex. Veins immersed, evident, 1 or 2 per lobe. *Sori* uni- or on the inner lobes binerval; indusium pale, subentire, 0.6–1 $\frac{1}{2}$  mm long, 0.3 mm wide, with approximately straight base, not reaching the margin by about twice its width, strongly reflexed and often concealed at full maturity. Spores pale brown, trilete, smooth, *c.* 28  $\mu$ .

Distr. *Malesia*: New Guinea (all 3 Divisions).

Ecol. Epiphytic in moist montane forest, 1000–1800 m.

Note. It is possible that in this species adult

plants may produce simply pinnate leaves.

**59. *Lindsaea versteegii* (CHRIST) v.A.v.R. Handb. Suppl. (1917) 206; COPELAND, Philip. J. Sc. 78 (1949) 18.**—*Odontosoria versteegii* CHRIST, Nova Guinea 8 (1909) 157.—Type: VERSTEEG 1222, Noord-Rivier, W. New Guinea (L; dupl. in B, BO, K, U; fragm. in US).—Fig. 39.

*Rhizome* long-scandent, 1–2 mm  $\sigma$ ,  $\pm$  permanently scaly; scales honey-coloured, triangular, to 2 mm long, up to *c.* 20-seriate, the apex scarcely uniseriate. Leaves  $1\frac{1}{2}$ –4 cm apart; *petioles* stramineous to medium brown,  $\pm$  lustrous, abaxially terete, adaxially narrowly sulcate, in simply pinnate leaves almost wanting, in bipinnate ones 10–15 cm long, shorter than the lamina. *Lamina* simply pinnate or bipinnate; if bipinnate oblong, *c.* 30 cm long, with *c.* 6 pinnae to a side and a conform terminal one; rachis like the petiole. *Pinnae* not strongly ascending, sessile, their width apart or slightly closer, linear, 10–15 cm long, 2–2 $\frac{1}{2}$  cm wide, shortly acuminate; upper pinnae somewhat shortened. Secondary rachises slender, stramineous, abaxially  $\pm$  distinctly bi-angular and sulcate. *Pinnules* thinly herbaceous, dark olivaceous when dry, spreading, close but scarcely contiguous, *c.* 25 to a side; larger pinnules arcuate-ligulate in outline, 10 to 12 by 4 to 5 mm, *c.*  $2\frac{1}{2}$  times as long as wide, the lower margin concave, the upper margin deeply incised; primary segments 4–6, the basal ones twice, the upper ones mostly once forked; *ultimate lobes* linear, divergent, 0.3–0.4 mm wide, almost parallel-sided to the spatulate soriferous apex, subacute if sterile, usually all lobes fertile, the fertile segments suddenly broadened at the sorus, there  $\frac{1}{2}$ – $\frac{3}{4}$  mm wide, the apex rounded or narrowed-rounded, subentire to erose; wings connecting the lobes about as wide as the lobes. Upper pinnules gradually and strongly reduced, confluent into the pinnatisect pinna-apex. Veins immersed, evident, single in the lobes. Simply pinnate leaves like the pinnae of bipinnate ones. *Sori* uninerval; indusium pale, delicate, subentire to erose,  $\frac{1}{4}$ – $\frac{3}{4}$  mm long,  $\frac{1}{4}$  mm wide, if long sometimes with concave base, otherwise semi-elliptic, with free sides, not reaching the margin by its own width to almost reaching it, somewhat reflexed at maturity. Spores pale brownish, trilete, smooth, 22–25  $\mu$ .

Distr. Beside the type known from one other collection from W. New Guinea (DOCTERS VAN LEEUWEN 10276, BO, K, L).

Ecol. Epiphytic in forest; one record 250 m.

Notes. It seems that adult plants may produce once and twice pinnate leaves side by side.

CHRIST (Geogr. d. Farne, 1910, 233) made the cryptic statement about this plant 'eine prächtige dimorphe Art mit halben Wasserblättern'.

The last three species, *L. microstegia*, *L. rosenstockii*, and *L. versteegii*, are very closely related and are perhaps not specifically distinct.

13. Section *Penna-arborea*

KRAMER, *Blumea* 15 (1968) 563.

Type species: *Lindsaea pulchella* (J. SMITH) METT. ex KUHN.

Distr. Malesia (except Malay Peninsula) to Polynesia and NE. Australia; most diversified in New Guinea. Epiphytes of moist montane forest.

Taxon. The affinity of the species included in this section was not before recognized; *L. pulchella* (J. SMITH) METT. ex KUHN was usually compared, and often confused, with *L. lucida* BLUME (mostly as *L. concinna* BLUME), *L. wernerii* ROSENSTOCK was associated with sect. *Synaphlebium*, because of its anastomosing veins, etc. The wiry, long-creeping, eventually  $\pm$  scaleless and polished rhizome with open xylem strand is quite distinctive. The lamina is unipinnate and the sori are interrupted.

60. *Lindsaea pulchella* (J. SMITH) METT. ex KUHN, *Linnaea* 36 (1869) 81; KRAMER, *Blumea* 15 (1968) 570.—*Odontoloma pulchellum* J. SMITH in Fielding & Gardner, Sert. Pl. (1844) pl. 51.—*Davallia pulchella* (J. SMITH) HOOKER, Sp. Fil. 1 (1845) 175, pl. 53 B.—Type: CUMING 217, Luzon (K; dupl. in B, BM, E, L, MICH, P, US, W).

*Aspidium adiantoides* BLUME, En. Pl. Jav. (1828) 145.—*Saccoloma adiantoides* (BLUME) PRESL, Tent. Pterid. (1836) 126.—*Davallia adiantifolia* HOOKER, Sp. Fil. 1 (1845) 176, non *Davallia adiantoides* SWARTZ.—*Odontoloma adiantoides* (BLUME) PRESL, Epimel. Bot. (1851) 97.—*Acrophorus adiantoides* (BLUME) MOORE, Ind. Fil. (1857) 91.—*L. adiantoides* (BLUME) KUHN in Miq. Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 278, non J. SMITH in Hooker (1846).—*L. adiantifolia* (HOOKER) COPELAND, Fern Fl. Philip. 1 (1958) 108.—Type: BLUME s.n., 'Java' (but probably from elsewhere).

*L. cyathicola* COPELAND, Philip. J. Sc. 1 (1906) Suppl. II, 149, pl. 5; Fern Fl. Philip. 1 (1958) 106.—Type: COPELAND 1938, Mt Bulusan, Luzon (MICH; dupl. in B, SING).

*L. marginata* BRAUSE, Bot. Jahrb. 56 (1920) 126.—Lectotype: LEDERMANN 11384, Hunstein-spitze, Sepik R. region, Terr. of New Guinea (B).

*L. alpestris* v.A.v.R. Bull. Jard. Bot. Btzg III, 5 (1922) 210.—Type: BÜNNEMEIJER 9907, Mt Kerintji, Sumatra (BO; dupl. in K, L, U; fragm. in BM, US).

*L. binervata* C. CHR. Bot. Jahrb. 66 (1933) 52.—Type: KJELLBERG 3632, Preho, Celebes (BM; dupl. in BO, S-PA).—Fig. 53-56.

*Rhizome* long-scandent, dark reddish brown to black, lustrous, wiry,  $\frac{1}{2}$ – $1\frac{1}{4}$  mm  $\phi$ ; scales deciduous, more persistent at the petiole-bases, elongate-triangular, to c. 8–10-seriate at base. Leaves one to a few cm apart, issuing at about right angles; *petioles* slender, wiry, less than 1 mm  $\phi$ . *Lamina* much longer than the petiole, linear, simply pinnate; *pinnules* asymmetrically ovate, semi-elliptic, ligulate, or rounded-trapezoidal, 2–3 times as long as wide; upper margin incised. Upper pinnules gradually and strongly reduced, basal pinnules farther apart and often  $\pm$  reduced. *Sori* usually uni- or binerval. Spores pale yellow, trilete, smooth, c. 20–25  $\mu$ .

KEY TO THE VARIETIES

1. Uninerval sori with straight or convex base; indusium falling short of the margin by its own

width or less; veins free or anastomosing; scales reddish brown, with a well-developed uniseriate apex . . . . . 4. var. *lomatosora*

1. Uninerval sori mostly with very concave base; indusium falling short of the margin by its own width or more (except sometimes at incisions); veins free; scales golden brown, apically very shortly uniseriate.

2. Pinnules herbaceous, mostly green when dry,  $4\frac{1}{2}$ –8 mm long, c. twice as long as wide, the major incisions less than  $\frac{1}{2}$  mm deep; adaxial and abaxial sides of petiole not discolorous . . . . . 1. var. *pulchella*

2. Pinnules herbaceous, mostly brown when dry, the larger ones 7–12 mm long, up to twice as long as wide, the major incisions 1–3 mm deep; petiole faces not discolorous.

2. var. *blanda*

2. Pinnules herbaceous to subcoriaceous, 10–16 mm long,  $2\frac{1}{2}$ –3 times as long as wide; incisions to 1 (sometimes to 2) mm deep; adaxial face of petiole much paler than abaxial side . . . . . 3. var. *falcata*

1. var. *pulchella*.—KRAMER, *Blumea* 15 (1968) 571.—*Aspidium adiantoides* BLUME.—*L. binervata* C. CHR.—Fig. 53.

*Rhizome*  $\frac{1}{2}$ – $\frac{2}{3}$  mm  $\phi$ ; scales narrowly triangular, golden-brown, to  $2\frac{1}{4}$  mm long, to c. 8-seriate at base, with a short uniseriate apex. *Petioles* 1–7 cm long, c.  $\frac{1}{4}$ – $\frac{1}{3}$  mm  $\phi$ , stramineous with dark base, or brown, abaxially rounded and bi-angular above or less often largely bi-angular, adaxially often pale-margined. *Lamina* 10–30 cm long, 0.8– $1\frac{1}{2}$  cm wide; rachis stramineous, quadrangular, often shallowly sulcate, wiry. *Pinnules* herbaceous, mostly pale to medium green when dry, in larger specimens c. 25–70 to a side, close to contiguous, alternate, spreading, asymmetrically ovate to semi-elliptic, the larger ones  $4\frac{1}{2}$ –8(–9) mm long, 2–4(–5) mm wide, c. twice as long as wide, mostly narrowed-rounded or subacute at the apex; margin not sclerotic, the upper margin with 1–3 very shallow incisions less than  $\frac{1}{2}$  mm deep, the lobes truncate-rounded or the outer ones with a small tooth; *upper pinnules* gradually and strongly reduced, several denticuliform ones confluent into a short, narrow, caudiform, pinnatifid leaf-apex. Veines immersed, evident, simple or once forked, ending well within the margin, mostly 1 mm apart. *Sori* uni- or binerval, often absent from part of the lamina; indusium elongate and often, especially

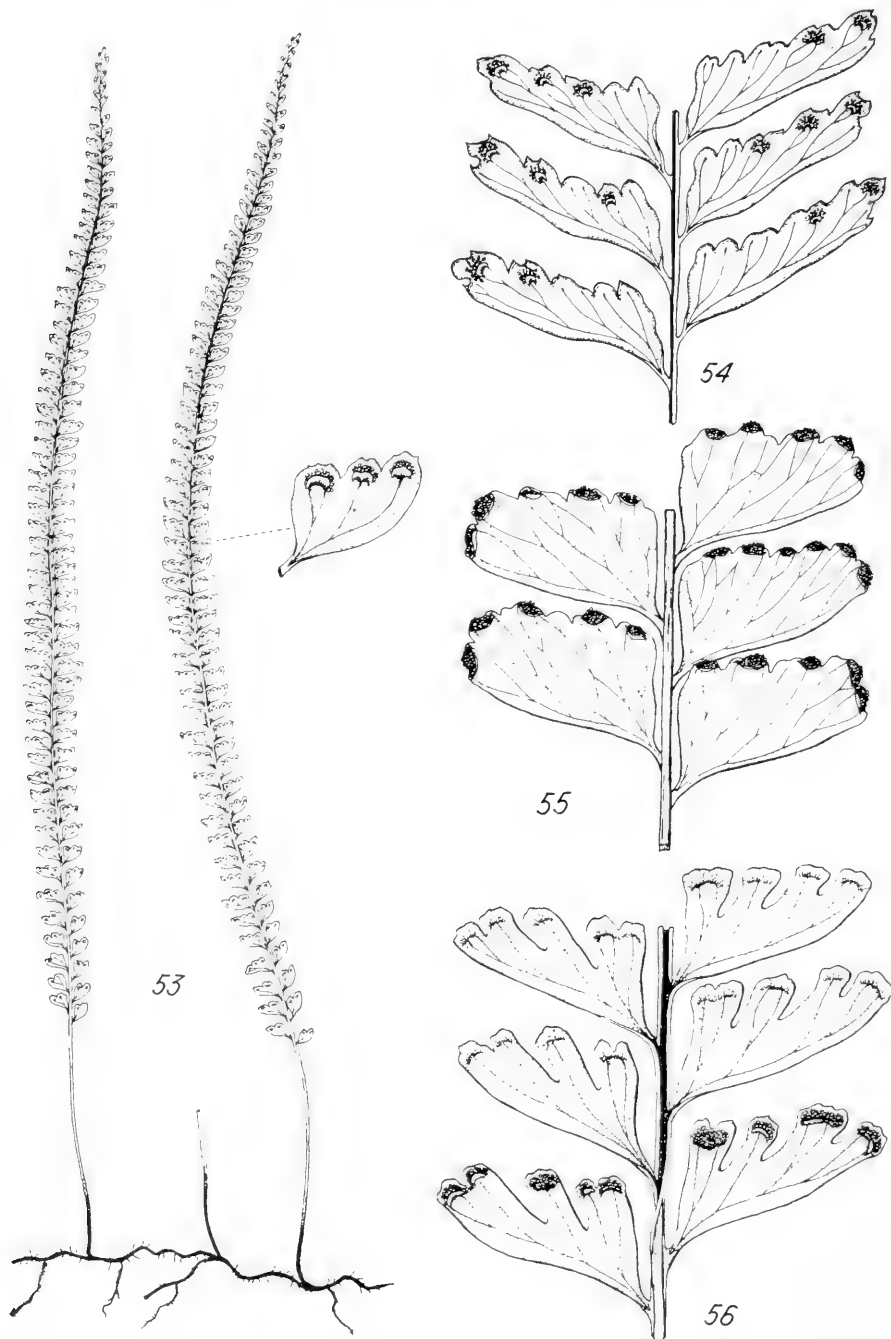
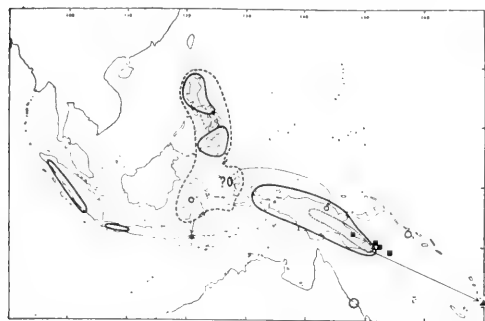


Fig. 53-56. *Lindsaea pulchella* (J. Sm.) Mett. ex Kuhn.—Fig. 53. var. *pulchella*. Part of a plant,  $\times \frac{1}{2}$ , pinnule,  $\times 3$  (Forsten s.n., L).—Fig. 54. var. *falcata* (Brause) Kramer. Part of a lamina,  $\times 2$  (Brass 13494).—Fig. 55. var. *lomatosa* Kramer. Part of a lamina,  $\times 2\frac{1}{2}$  (Brass 27911).—Fig. 56. var. *blanda* (Mett. ex Kuhn) Kramer. Part of a lamina,  $\times 3$  (Bunnemeijer 9907).

in outer sori, with concave base, or if uninervial ovate to subreniform and very obtuse to acute, variable in width, usually  $\frac{1}{4}$ – $\frac{1}{2}$  mm wide, often with irregular margin, not reaching the margin by less than its width to reaching it, laterally free, scarcely reflexed at maturity.

Distr. *Malesia*: Philippines (Mindanao, Negros, Mindoro, Luzon, Panay, Leyte), Moluccas (Halmahera, Ternate, Tidore, Buru), Celebes, Flores, New Guinea (1 coll.). Map 9.



Map 9. Distribution of *Lindsaea pulchella* (J. Sm.) METT. ex KUHN.—*var. pulchella* (lined), *var. blanda* (METT. ex KUHN) KRAMER (interrupted line, arrows!), *var. falcata* (BRAUSE) KRAMER (stippled line, arrow!), *var. lomatosora* KRAMER (squares).

Ecol. Epiphytic in moist forests, c. 600–2200 m, on trees and tree-ferns.

2. *var. blanda* (METT. ex KUHN) KRAMER, Blumea 15 (1968) 571.—*L. blanda* METT. ex KUHN, Linnaea 36 (1869) 80.—Type: WICHURA s.n., Java (B).

*L. alpestris* v.A.v.R.—*L. cyathicola* COPELAND.—Fig. 56.

*Rhizome* ( $\frac{1}{2}$ –) $\frac{3}{4}$ –1  $\frac{1}{4}$  mm  $\phi$ ; scales often a little longer and broader than in *var. pulchella*. *Petioles* 1–10 cm long,  $\frac{1}{2}$ – $\frac{2}{3}$  mm  $\phi$ , dark reddish brown or upward paler, hardly pale-margined, adaxially flattened, upward sulcate, abaxially bi-angular except at the rounded base. *Lamina* 5–30 cm long, 1–2  $\frac{1}{2}$  cm wide; rachis quadrangular, at least adaxially sulcate, stramineous or with darker base, wiry. *Pinnules* herbaceous, mostly olivaceous-brown when dry, c. 20–50 to a side, usually a little ascending, mostly not contiguous, asymmetrically ovate to  $\frac{1}{4}$ -elliptic, 7–12 mm long,  $3\frac{1}{2}$ –6 mm wide, twice as long as wide or slightly less; margins not or little sclerotic, a distinct outer margin usually not or scarcely developed, the upper margin with 1–3 oblique major incisions 1–3 mm deep, reaching  $\frac{1}{3}$  to  $\frac{1}{2}$  (rarely to  $\frac{2}{3}$ ) down, sometimes with some shallower additional incisions; lobes convex, not rarely erose,  $\pm$  divergent. Basal pinnules farther apart but scarcely reduced; upper pinnules gradually reduced, as in *var. pulchella*. Veins immersed, not evident, simple or once forked, free, ending well within

the margin,  $\frac{1}{2}$ –1 mm apart. *Sori* uni- or binervial or less often to 5-nervial,  $\frac{1}{2}$ –2(–4) mm long, in longer sori the base  $\pm$  concave. Indusium pale to brownish, delicate, subentire, with  $\pm$  convex free edge, narrowed at the free sides, 0.3–0.5 mm wide, nearly always strongly intramarginal.

Distr. *Malesia*: Sumatra, West and Central Java, Philippines (Luzon, Mindanao), Celebes, ? Ternate, New Guinea (all Div.); Queensland; Solomon Is. Map 9.

Ecol. Epiphytic, often among mosses, on trees and tree-ferns, very rarely terrestrial, from c. 1500 up to 2750 m.

3. *var. falcata* (BRAUSE) KRAMER, Blumea 15 (1968) 571.—*L. marginata* BRAUSE *var. marginata* et *var. falcata* BRAUSE, Bot. Jahrb. 56 (1920) 126–127.—Type: LEDERMANN 11384, Hunstein-spitze (*var. marginata*) (B), LEDERMANN 12864, Felsspitze (*var. falcata*), Sepik R. region, Terr. of New Guinea (B; dupl. in BM).

*L. rhombifoliolata* v.A.v.R. Nova Guinea 14 (1929) 29.—Type: H. J. LAM 1892a, crest to Doormantop, W. New Guinea (L).—Fig. 54.

*Rhizome* 1–1  $\frac{1}{4}$  mm  $\phi$ ; scales to  $\frac{2}{2}$  mm long, otherwise as in *var. pulchella*. *Petioles* c. 10–20 cm long,  $\frac{1}{2}$  mm  $\phi$ , adaxially flattened or shallowly sulcate, pale at least above, abaxially dark, rounded, bi-angular at least near the apex. *Lamina* c. 20–35 cm long, 2–3 cm wide, with c. 25–50 pinnules to a side; rachis abaxially dark, bi-angular, sometimes pale-angled, upward usually pale and sulcate, adaxially pale, sulcate. *Pinnules* herbaceous or usually subcoriaceous, dark brownish when dry, usually everywhere sclerotic-margined, somewhat ascending, not contiguous, ligulate, the larger ones 10–16 by 4–6 mm (2–) 2  $\frac{1}{2}$ –3 times as long as wide; upper margin with 2–4 narrow major incisions to 2 mm but usually only 1 mm or less deep, sometimes with some smaller additional ones, the lobes rounded, often with one or more teeth. Basal pinnules often more remote but scarcely reduced, upper pinnules gradually and strongly reduced, as in *var. pulchella*. Veins immersed, not evident, simple or once forked, lax, 1–2 mm apart. *Sori* uni- or binervial, usually with distinctly concave base,  $\frac{3}{4}$ –2 mm long; indusium pale, rather rigid, subentire to dentate or lobed, subhippocrepiform to crescent-shaped, narrowed at the free sides, usually strongly intramarginal but sometimes with protruding lobes, 0.3–0.5 mm wide, often reflexed at maturity.

Distr. *Malesia*: New Guinea (all Div.), Japan; New Hebrides (Aneityum). Map 9.

Ecol. Epiphytic, or terrestrial on mosses, 1300–1800 m.

4. *var. lomatosora* KRAMER, Blumea 15 (1968) 571.—Type: BRASS 27911, Mt Riu, Sudest I., Louisiades (L; dupl. in GH, K).—Fig. 55.

*Rhizome* scales reddish brown, to 1  $\frac{1}{4}$  mm long, with a well-developed uniseriate apex. Leaves up to 30 by 2 cm; faces of the *petiole* not or hardly discolored; *pinnules* green when dry, spreading

or slightly ascending, mostly ligulate or rounded-trapezoidal, scarcely narrowed at the apex; veins sometimes connivent or anastomosing, the series of areoles usually incomplete. *Margin* scarcely sclerotic, its incisions 1 mm deep or less; *sori* mostly binerval, basally scarcely concave or straight, if short more concave; indusium pale, delicate, 0.3 mm wide, falling short of the margin by less than its width to almost reaching it, often strongly bulging at maturity and then seemingly more strongly intramarginal. Otherwise much like *var. falcata*.

Distr. Louisiades, d'Entrecasteaux Is.; one less typical collection from the Territory of New Guinea. Map 9.

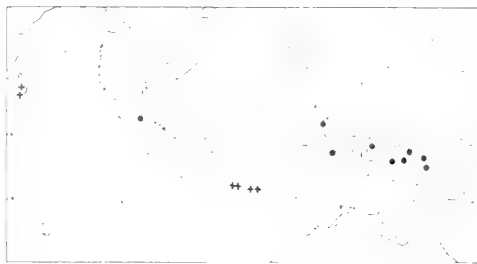
Ecol. Epiphytic on trees and tree-ferns, 250–900 m.

Note. The scales suggest a distinct species; but it is in other respects very much like the other varieties of *L. pulchella*.

**61. *Lindsaea wernerii* ROSENSTOCK** in Fedde, Rep. 5 (1908) 37; COPELAND, Philip. J. Sc. 78 (1949) 21.—Type: WERNER (ROSENSTOCK-exs. 19), Mt Gelu, Terr. of New Guinea (B; dupl. in E, L, P, S-PA, U).—Fig. 38.

*Rhizome* long-scandent, fawn-coloured, 0.6–1 mm  $\phi$ , deciduously scaly; scales light golden-brown, narrowly triangular, to 2 mm long, to 10-seriate at base, with a very short or virtually lacking uniseriate apex. Leaves 2–10 cm apart, issuing at about right angles; *petioles* quadrangular and sulcate almost to base, stramineous to reddish brown, often with paler angles, 4–15 cm long, somewhat shorter than the lamina. *Lamina* narrowly oblong, simply pinnate, 7–32 cm long, 3–6 cm wide, with 6–20 pinnules to a side, shortly acuminate; rachis stramineous, quadrangular, sometimes also quadrisulcate. *Pinnules* herbaceous, olivaceous when dry, spreading, alternate except the basal ones, their width apart to slightly overlapping, sessile, subtrapezoidal to semi-ovate-ligulate,  $1\frac{1}{2}$ –3 cm long, 6–12 mm wide, 2 to almost 3 times as long as wide; upper margin straight or outward convex, a distinct outer margin sometimes developed, then forming an angle of  $90^\circ$  or less with the upper; upper (and outer) margin shallowly crenate, if fertile with c. 5 incisions and  $\pm$  flat lobes, if sterile with more and closer incisions and rounded lobes, the deepest incisions to c. 1 mm, mostly not reaching the level of the receptacle. Few or very few upper pinnules suddenly reduced, one or two connected with the narrow, often caudate, to 4 cm long terminal segment. Veins immersed, evident, lax, anastomosing, forming an often incomplete series of areoles of varying length and  $1\frac{1}{2}$ –2 mm maximum width between the margins. *Sori* single in the lobes, most often binerval, sometimes tri- or uninerval, 1–3 mm long, with straight or somewhat convex receptacle; indusium pale, delicate, subentire, free at the sides, 0.3–0.4 mm wide, not reaching the margin by  $1\frac{1}{2}$ –2 times its width, reflexed and  $\pm$  concealed at maturity. Spores pale brown, trilete, smooth, c. 22  $\mu$ .

Distr. *Malesia*: Sumatra (one coll., SURBECK s.n., L), Moluccas (Halmahera, Ceram), New Guinea (W. New Guinea, Terr. of New Guinea). Map 10.



Map 10. Distribution of *Lindsaea wernerii* ROSENSTOCK (dots) and *L. glandulifera* v.A.V.R. (crosses).

Ecol. Epiphytic, or occasionally terrestrial, in dense, moist forests, 800–1800 m.

**62. *Lindsaea roemeriana* ROSENSTOCK**, Nova Guinea 8 (1912) 719; COPELAND, Philip. J. Sc. 78 (1949) 17.—Lectotype: VON RÖMER 731, Hellwig Mts, W. New Guinea (L; dupl. in BO).

*L. wollastonii* v.A.V.R. Handb. Suppl. (1917) 505, based on: *Odontosoria tenera* RIDLEY, Trans. Linn. Soc. II, Bot. 9 (1916) 254; non *L. tenera* DRYAND.—Type: B. KLOSS (WOLLASTON Exp.) s.n., Carstensz Peak, W. New Guinea (K; dupl. in BM).—Fig. 23.

*Rhizome* long-scandent, wiry,  $\frac{1}{2}$ – $\frac{3}{4}$  mm  $\phi$ , atropurpureous to blackish, lustrous, soon devoid of scales; scales honey-coloured, narrowly triangular, to 2 mm long, to 8-seriate at base, the uniseriate apex of one cell or wanting. Leaves remote,  $1\frac{1}{2}$ –5 cm apart; *petioles* stramineous except for the dark base, quadrangular almost to base, at least adaxially sulcate, 4–15 cm long, shorter than the lamina. *Lamina* narrowly oblong, 8–25 cm long, 2–3  $\frac{1}{2}$  cm wide, with 15–30 pinnules to a side; rachis similar to the petiole, upward narrowly green-margined. *Pinnules* herbaceous, olivaceous when dry, spreading, their width apart to subcontiguous, mostly alternate except the basal ones; larger pinnules semi-ovate in outline, 10–18 mm long, 5–8 mm wide, 2–2  $\frac{1}{2}$  times as long as wide, deeply pinnatifid from the upper margin, with 3–4 primary segments, the inner one or two forked; *segments* 0.3–0.6(–1) mm wide at the base, 0.5–1.5(–2) mm wide at the sorus, gradually widened below, more suddenly at the sorus, connected by a wing  $\frac{1}{4}$ – $\frac{1}{2}$  mm wide, rounded and crose to irregularly corniculate at apex. Sterile segments not broadened at apex, acute or subacute. *Basal pinnules* more remote and sometimes slightly reduced; upper pinnules (in the upper  $\frac{1}{3}$  or  $\frac{1}{2}$ ) reduced, the uppermost confluent into a small pinnatifid leaf-apex. Veins immersed, evident, solitary in the lobes. *Sori*

solitary near the apices of the lobes, uninerval; indusium delicate, ovate to hippocrepiform, subentire, free at the sides, 0.3–0.5 mm wide, 0.5–1 mm long, not reaching the margin by 1–2 times its width, scarcely reflexed at maturity. Spores very pale, trilete, smooth, c. 22  $\mu$ .

Distr. *Malesia*: New Guinea (W. New Guinea,

Terr. of New Guinea, 12 coll.).

Ecol. Epiphytic in mountain forests, c. 1200–2500 m.

Note. There are two extreme forms, one with more rounded lobes and sori with concave base, the other with erose lobes and ovate sori, but they pass into each other.

Excluded from *Lindsaea*  
(referred to *Isoloma*, *Lindsaea*, *Schizolegnia*, or *Schizoloma*)

*Isoloma dicksonioides* (CHRIST) TARDIEU-BLOT, Not. Syst. 14 (1952) 331 = *Nephrolepis dicksonioides* CHRIST.

*Isoloma lanuginosum* J. SMITH in Hooker & Bauer, Gen. Fil. (1842) pl. 102 = *Nephrolepis acutifolia* (DESVAUX) CHRIST.

*Isoloma lindsayae* (CHRIST) TARDIEU-BLOT, Not. Syst. 14 (1952) 331 = *Nephrolepis spec.*

*Lindsaea acutifolia* DESVAUX, Prod. (1827) 312 = *Nephrolepis acutifolia* (DESVAUX) CHRIST.

*Lindsaea amboynensis* (HOOKER) METT. ex KUHN in Miq. Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 279 = *Tapeinidium amboynense* (HOOKER) C. CHR.

*Lindsaea chinensis* (L.) METT. ex KUHN, Fil. Afr. (1868) 67 (*non* CHING, 1929) = *Sphenomeris chinensis* (L.) MAXON.

*Lindsaea cordata* (GAUD.) DESVAUX, Prod. (1827) 312 = *Schizolepton cordatum* (GAUD.) FÉE = *Taenitis cordata* (GAUD.) HOLTUM.

*Lindsaea cuneifolia* PRESL, Rel. Haenk. 1 (1825) 60 = *Sphenomeris retusa* (CAV.) MAXON.

*Lindsaea denhamii* (HOOKER) METT. ex KUHN, Verh. Zool. Bot. Ges. 19 (1869) 573 = *Tapeinidium denhamii* (HOOKER) C. CHR.

*Lindsaea grandifolia* J. E. SMITH in Rees, Cyclop. 21 (1812) no 12 = *Taenitis blechnoides* (WILLD.) SWARTZ teste ALSTON, Philip. J. Sc. 50 (1933) 180.

*Lindsaea hosei* C. CHR. Ind. Fil. (1906) 394, based on: *L. trilobata* BAKER, J. Bot. 29 (1891) 107 (*non* COLENSO, 1884) = *Taenitis trilobata* HOLTUM, Blumea 16 (1968) 93.

*Lindsaea lanuginosa* WALL. ex HOOKER, Sp. Fil. 1 (1846) 210, pl. 69 B = *Nephrolepis acutifolia* (DESVAUX) CHRIST.

*Lindsaea lowei* hort. = *Arthropteris oblitterata* (R. BROWN) J. SMITH teste C. CHR. Ind. Fil. (1906) 395.

*Lindsaea parishii* BAKER, Syn. Fil. ed. 1 (1867) 109 = *Stenochlaena sorbifolia* (L.) J. SMITH teste C. CHR. Ind. Fil. (1906) 625 = ? *Teratophyllum*.

*Lindsaea pinnata* (CAV.) METT. ex KUHN in Miq. Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 279 = *Tapeinidium pinnatum* (CAV.) C. CHR.

*Lindsaea pinnata* (CAV.) METT. ex KUHN var. *bipinnata* METT. ex KUHN in Miq. Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 279 = *Tapeinidium luzonicum* (HOOKER) KRAMER.

*Lindsaea retusa* (CAV.) METT. Fil. Lips. (1856) 105 = *Sphenomeris retusa* (CAV.) MAXON.

*Lindsaea trilobata* BAKER, J. Bot. (1891) 107 = see under *L. hosei* C. CHR.

*Lindsaea vittata* ZOLL. & MOR. Nat. Geneesk. Arch. N. I. 1 (1844) 400 = *Pteris* ?

*Schizolegnia stortii* (v.A.v.R.) ALSTON, Bol. Soc. Brot. II, 30 (1956) 24 = *Xyopteris stortii* (v.A.v.R.) KRAMER.

*Schizoloma cordatum* GAUD. Ann. Sc. Nat. 3 (1824) 507 = see under *Lindsaea cordata* (GAUD.) DESVAUX.

*Schizoloma ferulaceum* (MOORE) KUHN, Chaetopt. (1882) 346 = *Davallia spec.*

*Schizoloma hosei* (C. CHR.) COPELAND, Sarawak Mus. J. 2 (1917) 327 = see under *Lindsaea hosei* C. CHR.

*Schizoloma retusum* (CAV.) KUHN, Chaetopt. (1882) 346 = *Sphenomeris retusa* (CAV.) MAXON.

*Schizoloma stortii* v.A.v.R. Bull. Jard. Bot. Btzig II, 16 (1914) 36 = *Xyopteris stortii* (v.A.v.R.) KRAMER.

Doubtful species and varieties

*Lindsaea bipinnata* ROXBURGH, Calc. J. Nat. Hist. 4 (1844) 511.—Type: ROXBURGH *s.n.*, Prince of Wales' Island (Pulau Penang) (*n.v.*).

Judging from the description this is a large form of *L. parasitica*, with which ROXBURGH compared it; or it might be *L. doryphora*.

*Lindsaea decrescens* COPELAND, Philip. J. Sc. 81 (1952) 6, pl. 5.—Type: LOHER 13621, Umiray, Quezon Prov., Luzon (dupl. in MICH).

As stated by COPELAND, this is intermediate between *L. repens* ('*L. macraeana*, *L. longa*') and *L.*

*fissa*. The isotype in MICH from COPELAND's herbarium is rather scrappy. I doubt whether it represents a distinct species.

*Lindsaea longa* COPELAND, Philip. J. Sc. 46 (1931) 216.—Type: EDANÓ B.Sc. 77978, Mt Balagbag, Palawan (MICH; dupl. in GH).

This is probably only an unusually deeply incised form of *L. repens* (BORY) THWAITES var. *sessilis* (COPELAND) KRAMER.

*Lindsaea orbiculata* (LAMK) METT. ex KUHN var. *integra* METT. ex KUHN in Miq. Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 279.—Type: LOBB s.n., Java; also 'Ceylania'.

I have seen no specimen that can with certainty be regarded as the type. It is not impossible that it represents var. *commixta* for which it would then be an older name.

*Lindsaea striata* BLUME, En. Pl. Jav. (1828) 220.—Type: BLUME s.n., 'in Javae montibus altissimis' (n.v.).

The type of this species could not be found at L and is presumably lost. CHRISTENSEN (Ind. Fil. 1906) referred it to *L. orbiculata*; judging from the description and the provenience this is probably correct.

*Lindsaea tricrenata* BAKER, J. Bot. 28 (1890) 106.—Type: MCGREGOR 24, Mt Musgrave, New Guinea (K).

Compared with *L. rigida* and *L. borneensis* by its author, two species not closely related in the present author's opinion. The type is a detached, very poorly preserved, nearly sterile leaf of uncertain identity, and one can only marvel at BAKER's temerity to describe this as a new species.

*Vittaria interrupta* ROXBURGH ex GRIFFITH, Calc. J. Nat. Hist. 4 (1844) 511.—Type: ROXBURGH s.n., Prince of Wales' Island (Pulau Penang) (n.v.).

Referred to *L. orbiculata* by CHRISTENSEN (Ind. Fil.), to *L. tenera* by BEDDOME (Ferns Brit. Ind. 1, 1866). Judging from the description the latter opinion seems better; it would then be the oldest name for what is here called *L. bouillodii* CHRIST.

*Vittaria lunulata* ROXBURGH ex GRIFFITH, Calc. J. Nat. Hist. 4 (1844) 510.—Type: coll.?, Prince of Wales' Island (Pulau Penang) (n.v.).

Perhaps a simply pinnate form of *L. parasitica*; it is not stated whether the plant was terrestrial or epiphytic, with long or short rhizome, and its identity remains obscure.







## LOMARIOPSIS GROUP (R. E. Holttum, Kew)<sup>1</sup>

*Aspidiaceae sensu* CHING, Sunyatsenia 5 (1940) 247–253, p.p.; *Aspidiaceae sensu* COPEL. Genera Filicum (1947) 100–154, p.p. — *Dennstaedtiaceae subfam. Lomariopsidoideae* HOLTTUM, J. Linn. Soc. Bot. 53 (1947) 146–149. — *Lomariopsidaceae* ALSTON, Taxon 5 (1956) 25. — *Elaphoglossaceae* PICHI SERM. Webbia 23 (1968) 209–217.

*Rhizome* creeping or low-climbing (*Bolbitis*) or climbing (*Lomariopsis*, etc.) or epiphytic (*Elaphoglossum*), dorsiventral, with a broad ventral vascular strand which supplies the roots and one or more dorsal strands (the fronds in two or more longitudinal rows, according to the number of strands); *stipes* jointed to rhizome (*Teratophyllum*, *Elaphoglossum*) or not, containing several separate vascular strands; scales peltate or pseudopeltate, clathrate or not; no elongate unicellular hairs. Rhizomes of *young plants* always with one dorsal meristele, this condition persisting to the adult plant in *Teratophyllum* and many species of *Elaphoglossum*. Fronds simple (*Elaphoglossum*, *Bolbitis* spp.), pinnate (all but *Elaphoglossum*) or bipinnate (*Teratophyllum* and *Lomagramma* spp.), the pinnae on fronds of *Lomariopsis*, *Teratophyllum* and *Lomagramma* jointed to the rachis, terminal unjointed lamina present in *Lomariopsis*; distinctive *bathyphylls*, usually more dissected than *acrophylls*, present in genera with climbing rhizomes (least distinctive in *Lomariopsis*); veins free (*Teratophyllum*, *Lomariopsis*, most *Elaphoglossum*, some *Bolbitis*) or uniting near the margin (*Elaphoglossum* spp.) or in several series of areoles with (most species of *Bolbitis*) or without (*Lomagramma*; *Bolbitis* p.p.) free veins in the areoles. *Fertile fronds* with reduced lamina, covered beneath (rarely also above) with sporangia (except *Thysanosoria*, where sori are at ends of veins only), a special vascular supply for the sporangia variously developed or not; spores with perispore (except *Lomagramma*).

Genera. *Bolbitis* SCHOTT, *Lomariopsis* FÉE, *Lomagramma* J.SM., *Teratophyllum* METT., *Thysanosoria* GEPP, *Elaphoglossum* J.SM.; also *Peltapteris* LINK (*Rhipidopteris* FÉE ex SCHOTT) and *Microstaphyla* PRESL, small genera of tropical America and St Helena, allied to *Elaphoglossum* and not dealt with in the present work.

*Taxonomy.* In earlier systems species of all genera (except *Thysanosoria*) were included in *Acrostichum* because fertile leaflets are covered beneath with sporangia, without any distinction of separate sori. When PRESL and FÉE distinguished separate genera among such ferns, they depended mainly on venation, and so for example associated *Lomagramma* with the very different genus *Chrysodium* (now known as *Acrostichum s.str.*) because of similarity of venation, and *Egenolfia* and *Bolbitis* (here united as one genus) were placed wide apart because one had free veins and the other anastomosis. JOHN SMITH, who knew a large number of ferns from the living plants he cultivated at Kew, introduced habit of growth, and especially articulation of fronds to rhizome and pinnae to rachis, as additional characters, and thereby made further progress towards a natural system (Historia Filicum 1875).

In CHRISTENSEN'S Index Filicum (1905–06), based largely on the system of DIELS in Engler's Pflanzenfamilien (I, Abt. 4, 1899) the genera here included were ranked as follows: *Bolbitis* (excluding free-veined species, i.e. *Egenolfia*) and *Lomagramma* (excluding *L. polyphylla*) were treated as sections of the genus *Leptochilus* in tribe *Aspidieae*; *Egenolfia* was treated as a section of the genus *Polybotrya* (also in *Aspidieae*) and *Teratophyllum articulatum* with *Lomagramma polyphylla* were placed in section *Arthrobotrya* of the same genus; *Lomariopsis* and *Teratophyllum* (apart from *T. articulatum*) were merged with the genus *Stenochlaena* (not even distinguished as sections) in *Blechninae*, a subtribe of *Asplenieae*; the single species of *Thysanosoria* (a name not then established) was included in the genus *Notholaena* in *Pterideae*; *Elaphoglossum* was placed with *Acrostichum* in the tribe *Acrosticheae*.

In CHRISTENSEN'S first Supplement to his Index (1913) he recognized *Lomagramma* as a distinct genus, following COPELAND'S observations of Philippine spp. In 1931 he recognized that *Bolbitis* (under the name *Campium*) and *Egenolfia* are so closely related that they might well be united, and regarded them as 'acrostichoid derivatives from the *Dryopterideae*' (Contr. U.S. Nat. Herb. 26: 291). In 1932 I distinguished *Teratophyllum* and *Lomariopsis* from *Stenochlaena* (Gard. Bull. S. S. 5: 245–312) and demonstrated that the latter is peculiar in growth-habit, venation, anatomy and spores, so that it should belong to another

(1) The treatment of *Bolbitis* is by E. Hennipman, Leyden.

group of genera. In discussing the possible relationships of *Teratophyllum* and *Lomariopsis* I remarked on the similarity of their rhizome-structure and spores to those of *Bolbitis* and *Egenolfia*, suggesting that the four genera, and also *Lomagramma*, formed a natural group (l.c. 307–309). In 1938 this conclusion was accepted by CHRISTENSEN (in Verdoorn, Man. Pterid. 545) who regarded all the genera (with the addition of *Thysanosoria*) as acrostichoid derivatives allied to *Dryopteris*. In the same work (p. 549) CHRISTENSEN placed *Elaphoglossum* in a distinct subfamily (of *Polypodiaceae*) of doubtful relationship. CHING emphasized the isolation of *Elaphoglossum* by establishing a distinct family for it (Sunyatsenia 5, 1940, 265). When preparing my fern-flora of the Malay Peninsula, I was struck by resemblances between *Elaphoglossum* and *Lomariopsis*, and added *Elaphoglossum* to the group, which I called *subfam. Lomariopsidoideae* because *Lomariopsis* seemed to be a central genus (J. Linn. Soc. Bot. 53, 1947, 146–149). I placed this subfamily in a family *Dennstaedtiaceae*, not for nomenclatural reasons but because I wished to emphasize the idea that these ferns, and may be others, were likely to have evolved from something like *Dennstaedtia* and that their relationship to *Polypodium* is much more remote, so that the family name *Polypodiaceae* is quite inappropriate for them. In this broader aspect of classification my ideas have now changed somewhat (Brit. Fern Gaz. 9, pt 6, 1965, 205–212) but I still think that these genera form a natural group and that they should not be included in a family named *Polypodiaceae*. ALSTON (l.c.) proposed for them the family name *Lomariopsidaceae*, but included formally in his family only the genera found in West tropical Africa. COPELAND (1947) included all genera in his family *Aspidiaceae*, though regarding *Elaphoglossum* as not closely related to the others.

In 1949 I placed subfamily *Lomariopsidoideae* near *Davallioideae* (Bot. Rev. 24: 275, 290). I still think these two groups may be rather closely related, but would not consider them to have had a common origin from ferns like *Microlepia*. Some comments on other possible relationships are given below. The chromosome number 41, found in *Bolbitis*, *Lomariopsis*, *Teratophyllum*, *Lomagramma* and *Elaphoglossum* might indicate an association with *Davallia* or *Ctenitis* or *Dryopteris* (ROY & MANTON, J. Linn. Soc. Bot. 59, 1966, 343–347; T. G. WALKER, Trans. R. Soc. Edinb. 69, 1966, 178).

PICHI SERMOLLI (l.c. 1968) has argued that *Elaphoglossum* is not closely related to the other genera, and excluded it from a family *Lomariopsidaceae*. But he based this opinion mainly on a comparison between *Elaphoglossum* and *Bolbitis*, which admittedly are not closely allied. In my original proposal for its present assignment (J. Linn. Soc. Bot. 53, 1947, 149) I expressly compared *Elaphoglossum* with *Lomariopsis*, which I regarded as the central genus of the group. Young plants of most species of *Lomariopsis* (and adult plants of some African species), which have simple fronds, only differ conspicuously from *Elaphoglossum* in lack of articulation of fronds to rhizome. The range of spore-structure in the two genera is similar and I do not think it affords distinguishing characters. However, gametophytes of *Elaphoglossum* do appear to be sharply distinct from those of *Lomariopsis* (though the latter have not as yet been raised to maturity). The two genera have certainly had a long separate history and both are pantropic. Differences in both sporophyte and gametophyte may be due to adaptations to differences of habitat, to which gametophytes are probably more sensitive than sporophytes.

Ecology. The genera may be divided into three groups, according to growth-habits and ecological adaptations.

(1) *Bolbitis* (in Malesia) has short-creeping rhizome (except sometimes in young plants) usually growing on rocks or stream-banks in shady forest, sometimes climbing short distances up tree-trunks but never high-climbing. Pinnae are never jointed to the rachis, there being no need for adaptation to a dry season, but probably fertile fronds are produced in response to somewhat drier conditions.

(2) *Lomariopsis*, *Thysanosoria*, *Teratophyllum* and *Lomagramma*. Young plants start their lives on rocky or earthy banks of streams in tall evergreen forest, or on the exposed roots of trees, always in very humid conditions (some in fresh-water swamp forest), much as *Bolbitis*, but the rhizomes ultimately climb a considerable height up the trunks of trees (never into fully exposed positions), bearing spreading or drooping fronds. In all cases the pinnae are jointed to the rachis and shed when old; this is an adaptation to the high-climbing conditions in which the fronds are in air drier than near the ground (epiphytic orchids all have jointed leaves). In *Teratophyllum* the stipes are rather imperfectly jointed to the rhizome, leaving round scars when shed; in *Lomariopsis* and *Lomagramma* the stipe-bases are decurrent on the rhizome without a joint. In *Lomariopsis* the early fronds are simple and entire (dissected only in *L. variabilis* (WILLD.) FÉE of Mauritius) and are followed by pinnate fronds of increasing size, without any abrupt transition. In *Teratophyllum* the rhizome of a young plant climbing a tree-trunk near the ground has much-divided fronds, here called bathyphylls, of different form in different species, and there is a fairly abrupt transition to the simply pinnate adult condition. In *Lomagramma* young plants creep for some distance on stream-banks (often on rocks) with erect simply pinnate fronds of a distinctive kind, and show a rather abrupt transition to the adult condition, both as regards size of rhizome and of fronds, when they start to climb a tree. In all these genera the plants are rooted in the ground and draw their principal water-supply from the ground. *Thysanosoria* is exactly like *Lomariopsis* in its growth-form as an adult plant and probably resembles *Lomariopsis* in its young stages, though these have not yet been observed.

(3) *Elaphoglossum* species are all normally epiphytic (in Malesia). They have short-creeping rhizomes, to which the fronds are jointed; the joint is rather an imperfect one, between an outgrowth from the rhizome (phyllopodium) and the base of a frond (some American species have no joint). Fronds are thick and fleshy in many cases, especially those growing in more exposed positions in the crowns of trees; those growing near the ground in shade (e.g. *E. melanostictum*) have thinner fronds. The shedding of whole fronds, and their fleshy nature, are adaptations to the epiphytic condition (*Elaphoglossum* fronds are often much like leaves of orchids which grow with them).

The dorsiventral rhizome. The dorsal half of a creeping rhizome of *Bolbitis* has a vascular struc-

ture similar to that of *Dryopteris* or *Tectaria* but the ventral half of the *Bolbitis* rhizome is quite different, being specialized to root-bearing functions and carrying no fronds. There is no doubt that this structure is an advantage to ferns growing on stream-banks and subject to periodic submersion in swift-flowing flood-water. A similar structure is also well-adapted to the high-climbing condition, and to epiphytes which need to be firmly attached to tree-branches; it is found throughout the family *Polypodiaceae* (*s.str.*), the principal group of epiphytic ferns, though *Polypodiaceae* cannot be considered closely allied to the present group of genera.

As indicated below I suggest that the *Lomariopsis* group of genera are related to the *Tectaria* group; if so, they presumably evolved from ancestors with radially organized suberect stems. P. R. BELL has shown that some tropical American species of *Elaphoglossum* have a radially organized stem, though most are dorsiventral, and has found one species in which the change from dorsiventral to radial occurs in the development of a single plant (Ann. Bot. n.s. 19, 1955, 178-180). If one regards all genera of the present group as originating from ancestors with radially-organized rhizomes, BELL's plant indicates a reversion to the ancestral condition; whether all those tropical American species of *Elaphoglossum* which have radially organized rhizomes in the adult plant represent a similar reversion is an open question. It is also an open question whether the dorsiventral condition can have originated on more than one evolutionary line within the group of genera.

NAYAR makes a suggestion as to the origin of a dorsiventral rhizome from a radially symmetrical one, based on "some species of *Tectaria* in which some of the leaves on the ventral side of the procumbent or creeping rhizome are partially suppressed, and are associated with markedly smaller leaf-gaps in the stelar cylinder of the rhizome" (New Phyt. 65, 1966, 237). If such smaller leaf-gaps were completely suppressed a dorsiventral rhizome would result.

Inter-relationships. Assuming that this group of genera had a common ancestor, it was probably a terrestrial fern with dorsiventral creeping rhizome, bipinnate fronds with free veins and a tendency to contraction of fertile leaflets. Changes from this condition were: fronds in most cases to simply pinnate or simple; anastomosis of veins; a high-climbing rhizome and in conjunction with it the articulation of pinnae; loss of indusia and spreading of sporangia to cover the lower surface of reduced fertile leaflets. Some of these changes certainly occurred on more than one evolutionary line. *Bolbitis* represents the evolutionary line (or lines?) in which plants remained terrestrial and pinnae did not become articulated. It is more diversified than any of the other genera, especially in venation; those species which have free veins are primitive so far as that condition is concerned but not necessarily so in other ways.

Rhizome-scales indicate a division of the genera into two groups, those with clathrate scales and those with concolorous scales in which lateral cell-walls are not thickened. (It is notable that *Polypodiaceae s.str.* can also be thus subdivided). *Bolbitis* (in Malesia) and *Lomagramma* have (sub)clathrate scales; fronds of young plants in the two genera also show considerable resemblances. *Lomariopsis*, *Teratophyllum* and *Elaphoglossum* have non-clathrate scales. The bipinnate fronds of *Teratophyllum* sect. *Polyseriatae* may represent a primitive frond-form. Characters indicating possible cross-relationships between the groups of genera as defined by scales are: fronds of young plants of *Lomariopsis sorbifolia* and some allies in tropical America have much resemblance to those of young plants of *Lomagramma*; and paraphyses in *Lomagramma guianensis* which is of doubtful generic identity are like hairs on the margins of scales of *Lomariopsis*. *Elaphoglossum* is related only to *Lomariopsis*. I regard the development of a joint at the base of the lamina as a separate evolutionary development in this genus; it does not occur in all species (one may compare the orchid genera *Liparis* and *Oberonia*, in which some species have jointed leaves and some have not, the differences being related to the epiphytic condition).

CHRISTENSEN considered the whole group allied to his subfamily *Dryopteridoideae* (in Verdoorn, Man. Pterid. 1938, 545); within the subfamily he suggested a possible affinity of *Bolbitis* with *Tectaria* and its allies. I believe that *Pteridrys* is an ally of *Ctenitis* and *Tectaria*, wrongly placed in the *Thelypteris* group of genera by CHRISTENSEN (*l.c.* 544). The rachis structure and form of attachment of pinnae to rachis are closely similar in *Bolbitis* and *Pteridrys* (HOLTTUM, Rev. Fl. Mal. 2, 1954, 451, 529, fig. 263, 311). The sinus-teeth of *Pteridrys* resemble those of free-veined species of *Bolbitis* (HOLTTUM, *l.c.* fig. 270, 312); and *B. sinensis* (BAKER) K. IWATS. has a frond-form like that of *Pleocnemia* (*sensu proprio*; see HOLTTUM, Reinwardtia 1, 1951, 171-189) which I believe to be closely related to *Pteridrys*. The rachis structure and frond-form of *Dryopteris* are different, and a close relationship of *Bolbitis* to *Dryopteris* is unlikely. A closer study of the whole of CHRISTENSEN's *Dryopteridoideae* and the inter-relations of its parts is still needed.

As regards fertile fronds, the acrostichoid condition is clearly derivative, and within the *Lomariopsis* group (even within *Teratophyllum*) there are various ways in which the vascular system is adapted to it. KAUR (Bot. J. Linn. Soc. 68, 1974, 153) reported that the fertile segments of all lomariopsidoid ferns are provided with a diploidesmic venation; such a pattern is not present in *Bolbitis* (HENNIPMAN, Leid. Bot. Ser. 2, 1977, 35).

The question presents itself: what kind of discrete sori had the ancestors of the group? The little-known genus *Thyanosoria* perhaps gives an indication of the answer; it is so like *Lomariopsis* that the two could not be distinguished in the absence of fertile fronds. It has narrow fertile pinnae with separate sori at the vein-ends, each of which enters a small lobe on the pinna-margin, much as in some species of *Nephrolepis*. *Thyanosoria* sori however lack indusia and the sporangia are distributed a little distance from the end of the vein; a similar spreading has occurred in exindusiate species of many diverse genera which are normally indusiate (e.g. *Tectaria*, *Stegogramma*). One might therefore postulate an indusiate sorus at a vein-ending as the original fertile state of the group, but not necessarily a lobed margin with sori in the lobes.

It seems possible that the genus *Arthropteris* is more closely related to the *Lomariopsis* group of genera than is *Nephrolepis*. *Arthropteris* resembles *Teratophyllum* in slender climbing rhizome with dorsiventral

structure and two longitudinal rows of fronds on the dorsal surface, also in having the stipes jointed to the rhizome and pinnae to rachis. The jointing of stipe to rhizome is somewhat more definite than in *Teratophyllum*; there are phyllopodia projecting from the rhizome as in *Elaphoglossum* and *Oleandra*. The sori of *Arthropteris* are either indusiate (indusia reniform) or not, for which reason HOOKER placed one species in *Nephrolepis*, one in *Nephrodium* and one in *Polypodium*. The apex of the frond is in some species a terminal lobed lamina continuous with the rachis, in others a jointed pinna as in *Teratophyllum*. The spores have a perispore. The species of *Arthropteris* which most nearly resembles *Teratophyllum* is *A. tenella* (FORST.) J.Sm. of New Zealand and Australia; young plants of this species have been reported as having bipinnate fronds (CARSE, Trans. New Zeal. Inst. 47, 1911, 85).

*Arthropteris* differs from *Teratophyllum* in bearing abundant short multiseptate hairs, much as in *Ctenitis* and *Tectaria*. Such hairs are also abundant in *Davallodes*, a genus allied to *Davallia*, though the latter has almost glabrous adult fronds in all species (SEN, SEN & HOLTUM, Kew Bull. 27, 1972, 217). Thus *Arthropteris* shows possible relationships to both *Teratophyllum* and *Davallia*; in frond-form of some species it comes near to *Nephrolepis*, in others to *Ctenitis*. I conclude that *Arthropteris* looks like a separate offshoot from the *Ctenitis* stock, not nearly related to *Teratophyllum*, and that, with *Davallodes*, it may indicate relationships between *Ctenitis* and *Davallia*.

Spores of *Lomariopsis* and *Teratophyllum* were first figured by HOLTUM in 1932 (Gard. Bull. S. S. 5: 252). NAYAR and KAUR have described and illustrated spores of species from all genera in the group (Pollen et Spores 5, 1963, 87-94; J. Polyn. 1, 1965, 10-26). HENNIPMAN (Acta Bot. Neerl. 19, 1970, 671-680; Leid. Bot. Ser. 2, 1977, 38-46) studied several species of *Bolbitis* including some formerly referred to *Egenolfia* with both the transmission and scanning electron microscope. All Malesian species except those of *Lomagramma* have large folded perispore; but see note on species of *Lomariopsis* in Africa and America under that genus. Representative types of perispores are illustrated in fig. 26.

Gametophytes. NAYAR and KAUR (Bot. Rev. 37, 1971, 345-346) summarize published information on gametophytes of *Bolbitis*, *Egenolfia* and *Elaphoglossum*. Dr. L. R. ATKINSON (in Jermy *et al.*, Bot. J. Linn. Soc., Suppl. 1, 1973, 81) has made observations on gametophytes of four species of *Lomariopsis* (1 Malesian, 3 African) and one of *Lomagramma*, also of *Bolbitis* spp. including the American *B. cladorrhizans* (SPR.) CHING (a synonym of *B. portoricensis* (SPR.) HENNIPMAN). Gametophytes of *Elaphoglossum* differ from the other genera in their ribbon-like form with marginal rhizoids; for further comment, see *Elaphoglossum*. Gametophytes of *Lomariopsis* and *Lomagramma* have not yet been raised to maturity. In all cases spatulate young gametophytes are formed with a meristem along the anterior margin, no single apical cell being evident. Gametophytes of *Bolbitis portoricensis* and of *B. (Egenolfia) hookeriana* IWATS. (a synonym of *B. appendiculata* (WILLD.) IWATS.) are strap-like, those of the Malesian *B. heteroclitia* (PRESL) CHING and *B. repanda* (BL.) SCHOTT are broadly cordate and have curved multicellular hairs at the notch and along the anterior margins of the wings; such hairs are lacking in the other species. The sex organs of the lomariopsidoid ferns are of the so-called advanced type. Data on gametophytes, though not offering strong supporting evidence, do not contradict the idea of an alliance between the genera *Lomariopsis*, *Lomagramma* and *Bolbitis*. Gametophytes of *Teratophyllum* have not yet been studied.

- KEY TO THE GENERA
1. Fronds of adult plants simply pinnate or bipinnate.

2. Fronds of adult plants simply pinnate.

3. Veins all free.

4. Pinnae jointed to rachis; rhizome high-climbing with widely spaced fronds.

5. Terminal pinna not jointed to rachis at its base.

6. Fertile pinnae covered beneath with sporangia . . . . .

6. Sori separate at ends of veins . . . . .

5. Terminal pinna jointed at its base . . . . .

4. Pinnae not jointed; rhizome short . . . . .

3. Veins anastomosing.

7. Pinnae jointed to rachis; high-climbing plants . . . . .

7. Pinnae not jointed; short-creeping plants . . . . .

2. Fronds of adult plants bipinnate . . . . .

1. Fronds of adult plants simple.

8. Veins all free or united at margin only; fronds jointed to phyllopodia . . . . .

8. Veins freely anastomosing; no joint between frond and rhizome . . . . .

1. *Lomariopsis*

2. *Thysanosoria*

3. *Teratophyllum*

6. *Bolbitis*

4. *Lomagramma*

6. *Bolbitis*

3. *Teratophyllum*

5. *Elaphoglossum*

6. *Bolbitis*

1. LOMARIOPSIS

FÉE, Hist. Acrost. (1845) 10, 66-71, *p.p.*; J.Sm. Hist. Fil. (1875) 139; CHRIST, Farnkr. Erde (1897) 39, *p.p.*; HOLTUM, Gard. Bull. S. S. 5 (1932) 264-277; Not. Syst. 8 (1939) 48-62; Kew Bull. 1939, n. 10 (1940) 613-628; TARD.-BL. & C.CHR. Fl. Gén. I.-C. 7, 2 (1939) 427; BACKER & POSTH. Varenfl. Java (1939) 150; COPEL.

Gen. Fil. (1947) 117; Philip. J. Sc. 78 (1949) 400; Fern Fl. Philip. (1960) 267; HOLTUM, Rev. Fl. Mal. 2 (1954) 476; Blumea 14 (1966) 218. — *Acrostichum* sect. *Lomariopsis* HOOK. Spec. Fil. 5 (1864) 241, *p.p.* — *Lomariopsis* sect. *Eulomariopsis* METT. ex KUHN, Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 294. — *Stenochlaena* sect. *Eustenochlaena* DIELS in E. & P. Nat. Pfl. Fam. 1, 4 (1899) 251, *p.p.* — *Stenochlaena* sect. *Lomariopsis* UNDERW. Bull. Torr. Bot. Cl. 33 (1906) 37, 44–50; v.A.v.R. Handb. (1908) 718, *p.p.*; Suppl. (1917) 427, *p.p.* — **Fig. 1, 26d–e.**

*Rhizome* climbing, broad, rooting on ventral surface only and bearing several rows (to 5 or 6) of fronds on upper surface, densely scaly on younger parts; scales thin, brown, to 10 by 3 mm, base peltate (or cordate?), edges  $\pm$  fringed with hairs, lateral cell-walls not thickened; vascular system dorsiventric, showing in transverse section a broadly U-shaped ventral strand and above this a half-ring of wedge-shaped bundles with narrow leaf-gaps between them (fig. 1c). *Stipe* gradually decurrent at base to a ridge on rhizome, free part containing an open ring of c. 10 vascular strands, surface scaly when young; *fronds* simply pinnate, pinnae entire, jointed to rachis, terminal lamina pinna-like but not jointed; veins free, usually uniting with the (non-vascular) cartilaginous margin; surface when young bearing scattered minute fimbriate scales. *Pinnae of fertile fronds* much narrower than sterile, their lower surface completely covered with sporangia and small scales as on sterile pinnae; spores large, with copious folded perispore. *Young plants*: rhizome slender, bearing fronds in 2 rows; in Malesian *spp.* fronds simple and usually entire, successively larger to about 30 cm long, later fronds with smaller apical lamina and an increasing number of pinnae; fertile fronds usually not produced until the rhizome is of adult size and has climbed 2 m or more above ground.

Type species: *Acrostichum sorbifolium* L.

Distribution. Throughout the wetter parts of the tropics (America 15 *spp.*, W. Africa & Uganda 10 *spp.*, Islands of Indian Ocean 9 *spp.*, Asia, Malesia, Queensland, and Pacific 10 *spp.*).

Ecology. Plants of primary evergreen forest; prothalli growing on the ground or on exposed roots of trees, the slender rhizome creeping until it meets a tree-trunk, up which it climbs to 5–10 m, retaining a root-system in the ground. As the rhizome grows upwards successive fronds are borne in stronger light and less humid air. Fertile fronds are produced as a response to drier conditions according to local climatic change. Pinnae are deciduous but not whole fronds as *Teratophyllum*. In Luzon M. G. PRICE has found stunted fertile plants creeping on stones in a stream-bed in a semi-exposed position (see *L. lineata*).

Morphology. The broad  $\pm$  flattened dorsiventral rhizome, ridged on the dorsal surface with decurrent bases of fronds and bearing roots on the ventral surface is exactly as in *Lomagramma*. *Teratophyllum* sect. *Polyseriatae* differs only in having the bases of stipes a little constricted, not decurrent, and at length deciduous leaving round scars. Young plants of some species of *Lomariopsis* in other geographic regions differ in having fronds which are fully pinnate from an early stage, the terminal lamina never much larger than the lateral pinnae (e.g. *L. sorbifolia* and allied species in West Indies; see HOLTUM, 1940). In West Africa is one species which has simple fronds throughout its life (*L. palustris* (HOOK.) METT.). In Mauritius *L. variabilis* (WILLD.) FÉE has the early simple fronds more or less deeply dissected (they are comparable to mature sterile fronds of *Peltapteris*). In all cases there is a gradual transition from the frond-form of young plants to that of adult plants, without sharp distinction between bathyphylls and acrophylls.

Gametophytes have not yet been raised to maturity; for available information see p. 258.

Cytology. The only Malesian species investigated is *L. lineata* in cultivation at Kew, from root-tips ( $2n = 164$ , tetraploid with base 41; ROY & MANTON, J. Linn. Soc. Bot. 59, 1966, 343). Plants from West Africa, also at Kew, gave various different results, and two species also showed unevenness in size of chromosomes.

Spores. In Malesian species the perispore is  $\pm$  elaborately folded and in some cases is very large (NAYAR, New Phyt. 65, 1966, 235–236); in some species of tropical Africa and America it is not folded, or is produced into numerous small flattened appendages or spines which need to be examined by modern techniques. See fig. 26d–e.

Taxonomy. The genus was founded by FÉE in 1845; he included in it both *Lomariopsis* and *Teratophyllum* of the present treatment (except *T. articulatum*). JOHN SMITH cited *Acrostichum sorbifolium* L. as type species (Hist. Fil. 140, 1875); the choice of *L. cochinchinensis* FÉE by HOLTUM in 1932, copied by COPELAND (1947) was therefore illegitimate. Most other authors, if they did not follow HOOKER in retaining

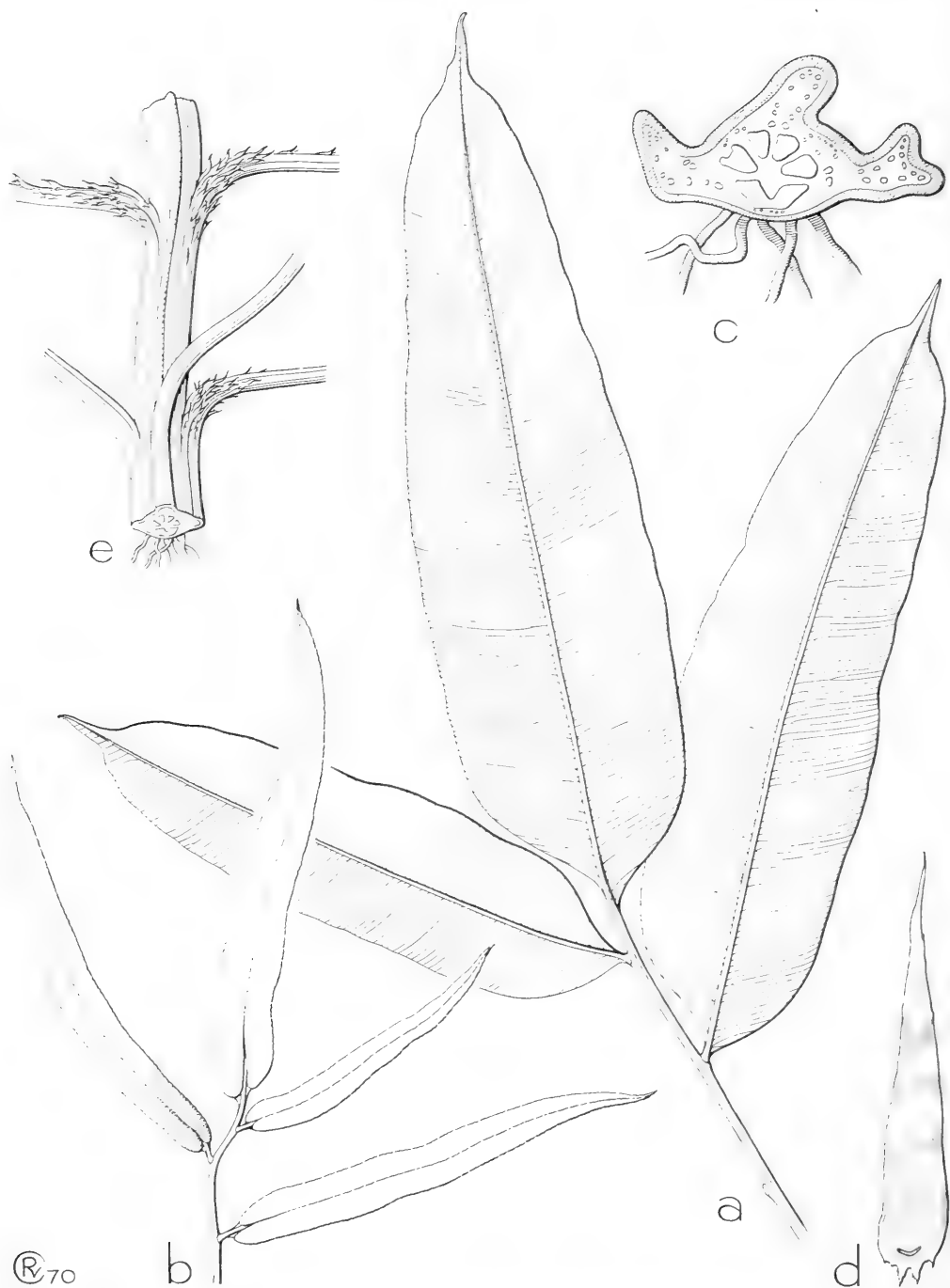


Fig. 1. *Lomariopsis intermedia* (COPEL.) HOLTUM. a. Apex of sterile frond,  $\times \frac{2}{3}$ , b. apex of fertile frond,  $\times \frac{2}{3}$ , c. CS of rhizome,  $\times 2$ , d. scale from base of stipe,  $\times 4$ . — *L. spectabilis* (KUNZE) METT. e. Rhizome and decurrent bases of stipes,  $\times \frac{2}{3}$  (a-d T. G. WALKER 10064, e ENDERT 3785).



FÉE's genus in *Acrostichum*, united it with *Stenochlaena* J.Sm. (1841). HOOKER (Spec. Fil. vol. 5) would not recognize most of FÉE's species as distinct and included nearly all of them (including those now separated as *Teratophyllum*) in the single species *A. sorbifolium*. In Farnkräuter der Erde (1897) CHRIST included also in this same species (as *Lomariopsis sorbifolia*) some Asplenoid ferns which have finely dissected fronds in their young stages and simply pinnate in adult condition; in this treatment he was uncritically followed by BOWER (The Ferns 3, 1928, 175-176). In Index Filicum (1906, 625-626) CHRISTENSEN attempted to distinguish twenty "subspecies (vel species?)" within *Stenochlaena sorbifolia*. UNDERWOOD was the first subsequent author to attempt to characterize the species (Bull. Torr. Bot. Cl. 33, 1906, 35-50); he recognized *Lomariopsis* and *Teratophyllum* (excl. *T. articulatum*) of the present work as sections of *Stenochlaena*. HOLTUM (l.c. 1932) pointed out distinctions between *Stenochlaena* and the other two genera in spores, scales, anatomy and venation, and later made observations on *Lomariopsis* in the islands of the Indian Ocean (1939) and tropical America and Africa (1940).

## KEY TO THE SPECIES

1. Sterile pinnae very coriaceous, drying brownish; fertile pinnae 10-20 mm wide; spores 90-110  $\mu$ m long excluding perispore.
2. Stalks of largest pinnae 5-20 mm long; apices of sterile pinnae rather abruptly short-acuminate; veins in sterile pinnae widely spaced and at c. 60° to costa . . . . . 1. *L. intermedia*
2. Stalks of lowest pinnae always short; apices of sterile pinnae gradually attenuate; veins of sterile pinnae less conspicuous, closer, at their bases almost at right angles to costa . . . . . 2. *L. subtrifoliata*
1. Sterile pinnae not very coriaceous, drying dark olive-green; fertile pinnae rarely to 10 mm wide; spores c. 45-65  $\mu$ m long excluding perispore.
3. Upper surface of fertile pinnae not over 2 mm wide; wing of spore narrow, lacking reticulate thickening . . . . . 3. *L. kingii*
3. Upper surface of fertile pinnae wider; wing of spore otherwise.
4. Sterile pinnae 3-5 cm wide, on young plants at least abruptly contracted to a short-acuminate apex; spores with ample folded perispore . . . . . 4. *L. lineata*
4. Sterile pinnae less than 3 cm wide (usually less than 2 cm), apex always gradually attenuate; spores bearing a perispore of many small wings . . . . . 5. *L. spectabilis*

1. *Lomariopsis intermedia* (COPEL.) HOLTUM, Gard. Bull. S. S. 5 (1932) 270; COPEL. Philip. J. Sc. 78 (1949) 400. — *Stenochlaena intermedia* COPEL. Philip. J. Sc. 7 (1912) Bot. 67; v.A.v.R. Handb. Suppl. (1917) 429. — Type: C. KING 370, Ambasi, Papua (MICH); dupl. in BM. — Fig. 1a-d, 26d.

*Rhizome* 15 mm or more wide, densely scaly near apex; scales to 10 by 3 mm. *Stipes* to 30 cm long; frond to 70 cm, pinnae to 10 pairs. *Sterile pinnae* 18-35 by 2½-5 cm, rather abruptly short-acuminate, conspicuously stalked (stalks of lowest pinnae 5-20 mm long), thick, rigid and brownish when dry, veins to 2 mm apart, simple or once forked, at c. 60° to costa. *Fertile pinnae* as long as sterile and similarly stalked, commonly 10-15 mm wide (to 20 mm); spores c. 100  $\mu$ m long excluding perispore which is very wide, elaborately folded, without conspicuous reticulate thickening.

Distr. *Malesia*: eastern half of New Guinea, Louisiade Archipelago.

Ecol. In forest, at 120-1950 m.

Note. This species is near *L. oleandrifolia* (BRACK.) METT. of Fiji. The latter has pinna-stalks 2½-3½ cm long, and sterile pinnae very abruptly contracted below the short narrow apex.

2. *Lomariopsis subtrifoliata* (COPEL.) HOLTUM, Gard. Bull. S. S. 5 (1932) 274; COPEL. Philip. J. Sc. 78 (1949) 400; Fern Fl. Philip. (1960) 269. — *Stenochlaena subtrifoliata* COPEL. Philip. J. Sc. 1 (1906) Suppl. 152; v.A.v.R. Handb. (1908) 721. (Not *Gymnogramma subtrifoliata* HOOK. 1864 which is *Lomariopsis brackenridgei* CARR.). — Type: COPELAND 1749, San Ramon, Mindanao (MICH).

Similar to *L. intermedia* in rigid sterile pinnae drying brownish and in wide fertile pinnae, differ-

ing as follows: pinnae never long-stalked even on large fronds; apices of pinnae gradually attenuate; veins of sterile pinnae closer, starting almost at right angles to costa.

Distr. *Malesia*: Philippines (southern Luzon, Leyte, Samar, Biliran, Mindanao).

Ecol. In forest near streams, at c. 800 m.

NOTE. One specimen from Mt Bulusan has fertile pinnae 8 mm wide, spores 83  $\mu$ m long.

3. *Lomariopsis kingii* (COPEL.) HOLTUM, Gard. Bull. S. S. 5 (1932) 273; COPEL. Philip. J. Sc. 78 (1949) 400. — *Stenochlaena kingii* COPEL. Philip. J. Sc. 6 (1911) Bot. 80; v.A.v.R. Handb. Suppl. (1917) 429. — Type: C. KING 285, Ambasi, Papua (MICH). — Fig. 26e.

*Rhizome* to 12 mm wide; leaf-gaps in vascular system up to 6; young parts and bases of stipes of young fronds densely scaly; scales thin, medium brown, to 10 by 3 mm, edges irregularly hairy when young. *Sterile pinnae* to 20 by 2½-3 cm, lower ones on stalks to 5 mm long, base unequally cuneate, widest in basal half, narrowed gradually to acuminate apex (sometimes a rather abrupt narrowing near apex), texture firm. *Fertile pinnae* to 20 cm long, upper surface 2 mm wide (sporangia spreading beyond edges of lamina may produce an apparent width of 3 mm or more); spores 50-65  $\mu$ m long excluding perispore which is not very wide and has few folds.

Distr. *Malesia*: Philippines (Mindanao to S. Luzon), New Guinea; Queensland.

Ecol. In forest, at 600-2000 m.

Note. This species is very near *L. brackenridgei* CARR. (from which I cannot clearly distinguish *L. setchellii* (MAXON) HOLTUM) distributed from Fiji to Tahiti, which has even narrower and longer fertile pinnae.

4. *Lomariopsis lineata* (PRESL) HOLTUM, Novit. Bot. Inst. Prag. 1968 (1969) 9. — *Olfersia lineata* PRESL, Tent. Pterid. (1836) 235. — *Acrostichum speciosum* PRESL, Rel. Haenk. (1825) 16, non WILLD. — Type: HAENKE *s.n.*, Philippines (PRC).

*L. cochinchinensis* FÉE, Hist. Acrost. (1845) 66, t. 26; HOLTUM, Gard. Bull. S. S. 5 (1932) 266; TARD.-BL. & C. CHR. Fl. Gén. I.-C. 7, 2 (1939) 428; COPEL. Philip. J. Sc. 78 (1949) 400; HOLTUM, Rev. Fl. Mal. 2 (1954) 476, f. 279. — *Stenochlaena cochinchinensis* (FÉE) UNDERW. Bull. Torr. Bot. Cl. 33 (1906) 46. — Type: GAUDICHAUD *s.n.* 1827, Tourane, Cochinchina (P; dupl. in B, K).

*L. smithii* FÉE, Hist. Acrost. (1845) 71, t. 33 f. II (excl. t. s. rhizome), t. 53 f. II; HOLTUM, Gard. Bull. S. S. 5 (1932) 269; COPEL. Fern Fl. Philip. (1960) 268. — *Stenochlaena smithii* UNDERW. Bull. Torr. Bot. Cl. 33 (1906) 50. — Type: CUMING 143, Luzon (P; dupl. in B, BM, K, L, MICH, US).

*Stenochlaena abrupta* v.A.v.R. Bull. Jard. Bot. Btż II, 20 (1915) 24; Handb. Suppl. (1917) 429. — Lectotype: AMDJAH 119, Pladjoe, Borneo (BO; dupl. in L, UC).

*L. papyracea* COPEL. Philip. J. Sc. 56 (1935) 104, pl. 1 f. 3; Fern Fl. Philip. (1960) 268. — Type: COPELAND *s.n.* 30-8-1932, Mindanao (MICH).

*Stenochlaena sorbifolia* [non (L.) J.S.M.] BEDD. Ferns Br. India (1866) t. 192; Handb. (1883) 423 *quoad* f. 254 *tantum*; v.A.v.R. Handb. (1908) 720, q.p.

*Acrostichum laurifolium* [non (PRESL) HOOK.] CHRIST, Ann. Jard. Bot. Btż 15 (1898) 177.

*Simple fronds* of young plants to 30 by 6 cm, with stipe to 15 cm; lamina abruptly contracted to a narrow apex 2 cm long. *Fronds of mature plant*, including stipe, to 100 cm long, pinnae to 20 pairs. *Sterile pinnae* to 20 by 5 cm, lowest on stalks 5-15 mm long, base narrowly cuneate on basiscopic side, broadly on acroscopic, edges almost parallel for most of length,  $\pm$  suddenly contracted to a narrow caudate apex 2-3 cm long, edges entire, texture subcoriaceous; upper pinnae often less abruptly contracted near apex. *Fertile pinnae* 8-15 cm long, 3-6(-10) mm wide; spores 43-50  $\mu$ m long excluding perispore which is wide with reticulate thickening.

DISTR. Tenasserim, S. Thailand, S. Vietnam; throughout *Malesia* except E. New Guinea.

ECOL. In wet lowland forest and to c. 1200 m; stunted fertile plants also observed in Luzon creeping on stones in seasonally dry stream-bed.

NOTES. FÉE's figures of *L. smithii* (based on CUMING 143, Luzon) show both fertile and sterile pinnae with very long stalks, but the specimen of this collection at Kew has stalks 3-5 mm long. In Malaya I have found plants growing near together, one with typically broad sterile pinnae, the other with pinnae only half as wide. The type specimen of *L. papyracea* has a normal sterile frond, with a contorted and incomplete fertile one having an apical lamina 16 mm wide; it seems to me improbable that this is a normal frond of a distinct species.

Specimens from Taiwan and Hainan which have been named *L. cochinchinensis* should perhaps be ranked as a distinct species; they are near *L. kingii*, having sterile pinnae 1½ cm wide, not abruptly contracted towards apex, and very narrow fertile pinnae.

A specimen consisting entirely of simple fronds, one of them fertile, was collected by M. G. PRICE (463) growing on stones in a seasonally dry streambed in a semi-exposed position, in Camarines Norte Province, southern Luzon. This is the only example of a simple fertile frond of this species seen by me; failure to produce pinnate fronds was doubtless a reaction to the exposed habitat.

5. *Lomariopsis spectabilis* (KUNZE) METT. Fil. Hort. Bot. Lips. (1856) 22; Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 294, excl. *spec. Zippelii*; HOLTUM, Gard. Bull. S. S. 9 (1937) 141; TARD.-BL. & C. CHR. Fl. Gén. I.-C. 7, 2 (1939) 428; COPEL. Fern Fl. Philip. (1960) 269 (p.p.). — *Lomaria spectabilis* KUNZE, Bot. Zeit. 6 (1848) 144. — *Acrostichum spectabile* (KUNZE) RACIB. Fl. Btż 1 (1898) 54, non ZOLL. — *Stenochlaena sorbifolia* var. *spectabilis* v.A.v.R. Handb. (1908) 721. — Type: ZOLLINGER 395, W. Java (L).

*Acrostichum smithii* RACIB. Bull. Int. Acad. Sci. Lett. Cracovie, Cl. Math. & Nat. B (1902) 59, non BAKER. — *Stenochlaena raciborskii* C. CHR. Ind. Fil. (1905) 18, 625 (new name for *A. smithii* RACIB.); v.A.v.R. Handb. Suppl. (1917) 428. — *Stenochlaena smithii* (RACIB.) v.A.v.R. Handb. (1908) 720. — *L. raciborskii* (C. CHR.) HOLTUM, Gard. Bull. S. S. 5 (1932) 272. — Type: cult. Hort. Bog. origin Moluccas, J. J. SMITH, II.K(V) 23; II.K(XIV) 41 (BO).

*Lomaria variabilis* (non WILLD.) BL. En. Pl. Jav. (1828) 263.

*Stenochlaena leptocarpa* (non FÉE) UNDERW. Bull. Torr. Bot. Cl. 33 (1906) 47 *quoad* syn. *tantum*; v.A.v.R. Handb. Suppl. (1917) 428, p.p.

*L. leptocarpa* (non FÉE) HOLTUM, Gard. Bull. S. S. 5 (1932) 270. — Fig. 1e.

Lamina of *simple fronds* of young plants to 30 by 1.2 cm, narrowed gradually to apex; pinnae of first pinnate fronds sessile. *Fronds of mature plants* 70 cm or more long, pinnae c. 15 pairs. *Sterile pinnae* of largest fronds commonly 20 by 1½ cm, rarely to 2½ or 3 cm wide, lowest with stalks to 10 mm long, apices acuminate (not abruptly narrowed), when dry rigid and brittle, dark olive-green. *Fertile pinnae* to 25 cm long, 4-5 mm wide, stalked as sterile; spores about same size as those of *L. lineata*, perispore consisting of many small wings.

DISTR. *Malesia*: Central & South Sumatra, Java, Bali, Borneo, Moluccas; Celebes?; Philippines?.

ECOL. In forest, at 1250-1500 m.

NOTES. *Acrostichum smithii* RACIB. was described from a plant brought from the Moluccas (exact locality unrecorded) by J. J. SMITH. The fronds of the type had few pinnae, sterile ones to 3 cm wide; a later-collected frond, apparently from the same plant, has 6 pairs of pinnae less than 2 cm wide. No other collections are known from the Moluccas.

Specimens from the Philippines formerly referred to this species all appear to have narrower fertile pinnae and I believe they must be regarded as *L. kingii*. Bornean specimens referred here are few and have broad fertile pinnae; their sterile pinnae are thinner and somewhat broader than those of specimens from Java but are narrowly acuminate, not abruptly narrowed near apex as in *L. lineata*. The spores of Kinabalu specimens are somewhat intermediate between those of *L. lineata* and of

typical *L. spectabilis* in form of perispore; but those of ENDERT 3785 from 1200 m in W. Kutai are very like spores of Java specimens.

#### Excluded

*Lomariopsis hügelii* PRESL, Epim. Bot. (1851)

263 = *Blechnum filiforme* (A.CUNN.) ETTINGS. Type: HUGEL, New Zealand in Herb. PRESL, seen; duplicate in W. (Not *Stenochlaena hügelii* UNDERW. Bull. Torr. Bot. Cl. 33 (1906) 46 which is *Teratophyllum brightiae* (F.V.M.) HOLTTUM; see Blumea 14 (1966) 218).

## 2. THYSANOSORIA

GEPP in Gibbs, Dutch N.W. New Guinea (1917) 193, pl. 4; COPEL. Gen. Fil. (1947) 117. — Fig. 2.

Like *Lomariopsis* FÉE in habit and in form of sterile fronds, differing in fertile pinnae which have a small rounded marginal lobe at each vein-ending, the sporangia in separate sori, one at the end of each vein and spreading a little backwards along the vein, without indusia.

Distribution. One species, known only from two collections from neighbouring localities in NW. New Guinea, one in 1875, the other in 1913.

Notes. The second collection, as illustrated in GEPP's plate above cited, shows rhizome and frond-characters exactly matching *Lomariopsis*, and I agree with CHRISTENSEN in regarding the two genera as closely related. Possibly the sori of *Thysanosoria* show a stage in the evolution of the acrostichoid condition of *Lomariopsis*. Alternatively, Dr HENNIPMAN suggests that the two specimens named *Thysanosoria* may represent an abnormal condition of a species of *Lomariopsis*; but the collection of identical material after an interval of nearly 40 years is against this. The similarity of the fertile pinnae of *Thysanosoria* to *Nephrolepis* was noted by GEPP; but in vegetative habit and in spores the two genera are very different.

1. *Thysanosoria pteridiformis* (CESATI) C. CHR. Ind. Fil. Suppl. 3 (1934) 187; Dansk Bot. Ark. 9, 3 (1937) 51; PICHI SERMOLLI, Webbia 32 (1977) 91. — *Gymnogramme pteridiformis* CESATI, Rend. Acad. Napoli 16 (1877) 30. — *Notholaena pteridiformis* (CESATI) BAKER, Malesia 3 (1886) 49; v.A.v.R. Handb. (1908) 484. — Type: BECCARI s.n., Andai (FI, Herb. BECCARI 12704; dupl. in K).

*T. dimorphophylla* GEPP in Gibbs, Dutch N.W. New Guinea (1917) 193, pl. 4. — Type: L. S. GIBBS 6162 (BM). — Fig. 2.

Rhizome as *Lomariopsis*; young parts covered with peltate scales. Stipe of sterile frond 7–9 cm long; pinnae to 8 pairs, jointed to rachis, terminal lamina pinna-like but not jointed at its base; pinnae sessile, c. 15 cm long, 1.8–2 cm wide, entire, rather thin; veins simple or forked near costa, joining to edge which is pale, slightly thickened and slightly crisped when dry. Fertile pinnae 10–15 cm long, 6 mm wide when mature (BECCARI's specimen), edge with a small rounded projection at the end of each vein; sori on distal part of each vein, c. 2 mm apart, hemispherical when young. Spores with broad winged perispore (width of wing = half diameter of spore) with a few irregular folds.

Distr. Malesia: NW. New Guinea.

Ecol. "Common, climbing in karang forest" (GIBBS 6162). Karang is a belt of coral limestone near the coast.

Notes. The two collections differ in the following ways. BECCARI's sterile fronds have only 3 pairs of pinnae, those of GIBBS 6–8 pairs. BECCARI's fertile fronds are old, with pinnae 6 mm wide (Kew specimen; PICHI SERMOLLI reports 7–12 mm), those of GIBBS young and not over 3 mm wide; the latter would have been wider when old, but perhaps not to 6 mm. Sterile plants would look very much like *Lomariopsis kingii*, and it is possible that some

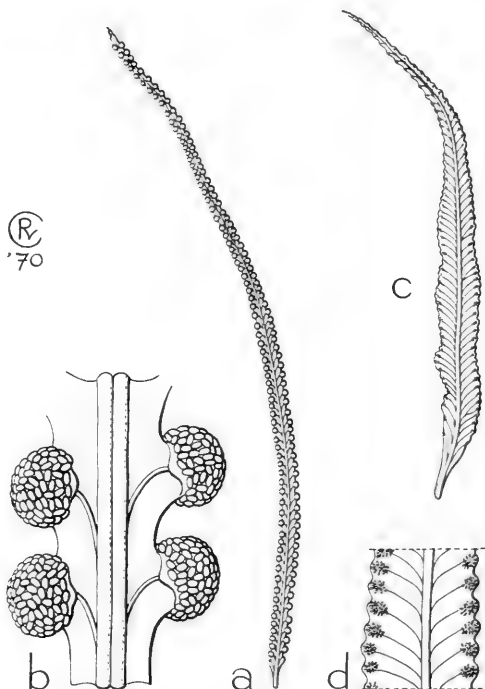


Fig. 2. *Thysanosoria pteridiformis* (CESATI) C. CHR. a. Young fertile pinna,  $\times \frac{2}{3}$ , b. part of a, upper surface, showing reflexed sorus-bearing lobes,  $\times 6$ , c. old fertile pinna,  $\times \frac{2}{3}$ , d. part of c, slightly enlarged (a-b GIBBS 6162, c-d BECCARI s.n. 1872).



Fig. 3. *Teratophyllum aculeatum* (BL.) METT. ex KUHN. Normal bathyphylls on tree-trunk, Fraser's Hill, Malaya (Photogr. R. E. HOLTUM).

sterile specimens credited to that species are *Thysanosoria*. The spores of *Thysanosoria* are very much like those of *L. kingii*.

PICHI SERMOLLI (*l.c.*) regarded the collections of BECCARI and GIBBS as representing two distinct species. The differences he cited include number of pinnae, but probably young plants of *Thysanosoria*, like those of *Lomariopsis*, have simple fronds, the number of pinnae in subsequent fronds gradually increasing with decrease in size of the apical lamina; in some cases fertile fronds with few pinnae are produced. As regards differences he described in the fertile pinnae, he failed to note that those on the GIBBS specimen are young and not fully expanded; the apical part of a Kew pinna from BECCARI is not greatly different from the GIBBS specimen in width, and the sori on the BECCARI specimen are not all wholly intramarginal.

### 3. TERATOPHYLLUM

METT. *ex* KUHN, Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 296; HOLTUM, Gard. Bull. S. S. 5 (1932) 277–304; *ibid.* 9 (1938) 355. — *Stenochlaena sect. Teratophyllum* UNDERW. Bull. Torr. Bot. Cl. 33 (1906) 37. — **Fig. 3–8.**

*Rhizome* scandent, dorsiventral, bearing on the ventral surface roots only and on the dorsal surface fronds alternately in 2 rows (*sect. Teratophyllum*) or at maturity in several rows (*sect. Polyseriatae*); bases of stipes swollen and  $\pm$  articulate to rhizome; rhizome-scales small, peltate, appressed, fugacious, not clathrate. *Fronds* of young plants, or on branches of old plants near ground level (bathyphylls) of a distinctive form characteristic of each species, often bipinnate, with winged rachis and pinnae jointed to it; *fronds of high-climbing rhizomes (acrophylls)* larger, simply pinnate (*sect. Teratophyllum*) or sometimes bipinnate (*sect. Polyseriatae*), all pinnae (including the apparently apical one) subequal and jointed to rachis; veins in sterile pinnae or pinnules free, simple or forked; scales small, peltate, with marginal hairs ending in glandular cells; *fertile pinnae* or pinnules much narrower than sterile, their lower surfaces covered with sporangia, the lamina thicker than that of sterile leaflets and containing an additional vascular system close to the surface which bears the sporangia, the strands of this vascular system often anastomosing; paraphyses like the small scales on sterile frond but with a stalk of 5–8 cells; spores with folded perispore.

Distribution. Peninsular Thailand and Lower Burma; throughout Malesia to N. Queensland, eastwards to Tahiti and south to New Caledonia.

#### KEY TO THE SECTIONS

1. Fronds always in 2 rows on dorsal surface of rhizome; all acrophylls simply pinnate. *Spp.* 1–9  
1. *Sect. Teratophyllum*
1. Fronds of fully developed rhizome in more than 2 rows; acrophylls bipinnate or pinnate (in Malesian *sp.* 10 bipinnate) . . . . . 2. *Sect. Polyseriatae*

#### 1. Section Teratophyllum

HOLTUM, Gard. Bull. S. S. 9 (1938) 355. — *Stenochlaena* J.SM. in Hook. J. Bot. 3 (1841) 401; *ibid.* 4 (1841) 149, *p.p.*; PRESL, Epim. Bot. (1851) 165, *p.p.*; J.SM. Hist. Fil. (1875) 312, *p.p.*; BEDD. Handb. Ferns Br. India (1883) 423, *p.p.* — *Stenochlaena sect. Eustenochlaena* DIELS in E. & P. Nat. Pfl. Fam. 1, 4 (1899) 251, *p.p.* — *Stenochlaena sect. Teratophyllum* UNDERW. Bull. Torr. Bot. Cl. 33 (1906) 37, 40, 41; v.A.v.R. Handb. (1908) 722; Suppl. (1917) 428. — *Lomariopsis* FÉE, Hist. Acrost. (1845) 71, *p.p.*; J.SM. Hist. Fil. (1875) 139, *p.p.*; CHRIST, Farnkr. Erde (1897) 39, *p.p.* — *Acrostichum sect. Lomariopsis* HOOK. Spec. Fil. 5 (1864) 242, *p.p.*; *sect. Stenochlaena l.c.* 249, *p.p.* — *Acrostichum* L. in Racib. Fl. Btztg 1 (1898) 53, *p.p.* — *Teratophyllum* METT. *sensu* HOLTUM, Gard. Bull. S. S. 5 (1932) 277; *ibid.* 9 (1937)

142; Rev. Fl. Mal. 2 (1954) 470; C. CHR. Ind. Fil. Suppl. 3 (1934) 186; BACKER & POSTH. Varenfl. Java (1939) 151; COPEL. Gen. Fil. (1947) 117; Fern Fl. Philip. (1960) 269.

Type species: *Lomaria aculeata* BL.

Distribution. Mergui and Peninsular Thailand; throughout Malesia, except Lesser Sunda Is.; 9 spp.

Ecology. Confined to primary forest. Prothalli grow on exposed tree-roots or bases of buttresses; young sporophytes develop a slender rhizome which usually grows upwards and may branch (in *T. ludens* it produces long trailing branches which pass along the ground from one tree to another) bearing successively larger and more complex bathyphylls, the earlier ones often asymmetric, with lamina more fully developed on lower side, with a more or less abrupt transition to acrophylls at c. 2 m above ground level. Fertile fronds produced at 3–5 m or more above ground, seasonally (probably in response to short periods of drier weather, which in many parts of Malesia are of irregular occurrence). A copious root-system develops on the lower parts of the climbing stem, spreading in the soil, and I believe this to provide most of the water needed by the plant. KARSTEN, believing *Teratophyllum* plants to lack such a soil-penetrating root-system, suggested that the chief function of bathyphylls is water-absorption (Ann. Bot. 12, 1895, 143–150). Bathyphylls can absorb some water, but not enough to be of much importance; and they do not always lie in close contact with the bark of the supporting tree, as described by KARSTEN (see fig. 3).

Vegetative morphology. See HOLTUM, Gard. Bull. S. S. 5 (1932) 277–283. Bathyphylls were formerly considered to be abnormal growths, but they are quite normal, and are distinctive in each species, showing a series of forms from the simple lamina of the first fronds to the pinnate (often bipinnatifid) condition of normal bathyphylls. In the pinnate condition, the lower pinnae are jointed to the rachis but the distal ones are not, becoming merged in an apical lamina. By contrast, all pinnae of acrophylls are jointed at their bases and are caducous; the apparently apical pinna is probably a lateral one which takes a terminal position, the true apex being suppressed. In some cases transition bathyphylls are found, with pinnae much as in normal bathyphylls but all pinnae jointed; I have not seen intermediate stages between these and normal bathyphylls. It seems possible that transition bathyphylls are borne on strong new branches arising near the base of an old plant.

The adult rhizome has always a gutter-shaped root-bearing ventral vascular strand, and a smaller dorsal one (fig. 6j); fronds are borne on the dorsal side, alternately to right and left of the dorsal strand. The arrangement of vascular strands in the stipe is like that on *Dryopteris* and *Tectaria* (fig. 6k). The very narrow fertile pinnae are fleshy, with a special development of vascular strands near the convex sporangia-bearing surface (HOLTUM, l.c.; NAYAR, New Phyt. 65, 1966, 221–239); in the narrower pinnae of *Teratophyllum aculeatum* and other species these strands anastomose rather irregularly, but in the broad fertile pinnae of *T. rotundifoliatum* they do not. Probably such independent vascular supply for the sporangia has evolved independently in various unrelated genera as a necessary adjunct to the acrostichoid state. The fertile pinnae show no indication of an indusium-like thin edge, such as occurs in *Stenochlaena*.

Cytology. The only observation is from roots of a plant of *T. ludens* in cultivation at Kew, showing  $2n = 82$ .

Taxonomy. The two species native in Java were first described by BLUME (1828) in the genus *Lomaria*; he saw bathyphylls and thought they were fertile fronds. JOHN SMITH, when enumerating CUMING's Philippine ferns (1841) established a new genus *Stenochlaena*, and stated, on the evidence of CUMING's specimens, that *Stenochlaena scandens* (now known as *S. palustris* (BURM. f.) BEDD.), the type-species of *Stenochlaena*, sometimes produced abnormal bipinnate fronds. These fronds were bathyphylls of *Teratophyllum aculeatum*, which were associated with normal sterile and fertile fronds of *Stenochlaena palustris* by CUMING under his n. 347, as shown by specimens in JOHN SMITH's herbarium (BM), one annotated by him. This idea persisted with SMITH and is repeated in his last book (Hist. Fil. 1875); it was also accepted by HOOKER (Spec. Fil. 5: 250) and by BEDDOME (Handb.) who so named a specimen of *T. aculeatum* bearing bathyphylls collected by WALLICH in Penang in 1822. WALLICH had given the name *Davallia achillaeifolia* to this specimen, and the name was formally published, with a figure, by HOOKER (Spec. Fil. 1: 195), with doubts expressed as to the affinity of the fern and a reference to its resemblance to *Lomaria aculeata* BL. BAKER named similar ferns from Moulmein *Lindsaea parishii* in 1867. Even as late as 1929 COPELAND wrote of "the polymorphism of the fronds of immature plants" of *Stenochlaena palustris* (Univ. Cal. Publ. Bot. 16: 75). Sporeling plants of *S. palustris* are very rare in Malaya, though mature plants are abundant and frequently fertile. I have however raised young plants from spores. Their first fronds were simple, then simply pinnate, showing from the first the leaflet-form and venation of *Stenochlaena*, quite unlike *Teratophyllum*. I can confidently assert that no true *Stenochlaena* produces fronds which could be confused with the bathyphylls of *Teratophyllum*. It should be noted that young plants of *Asplenium epiphyticum* COPEL. also produce bathyphylls. These were confused with those of species of *Teratophyllum* by CHRIST, who concluded that "*Stenochlaena*" was an acrostichoid derivative of Asplenoid origin; COPELAND accepted this derivation as "absolutely clear" in 1929. (See CHRIST, Philip. J. Sc. 2, 1907, Bot. 166; also his earlier composite fig. 96, p. 40, under *Lomariopsis sorbifolia*, which included fronds of *Lomariopsis*, *Teratophyllum* and *Asplenium*, in Farnkr. der Erde, a figure copied without question by BOWER in The Ferns 3, fig. 697).

In his monograph of the acrostichoid ferns (1845) FÉE did not mention *Stenochlaena palustris*. He included the species of *Teratophyllum* sect. *Teratophyllum* known to him in his new genus *Lomariopsis*; the



species were *L. spinescens* (*Lomaria aculeata* BL.), *L. leptocarpa* (based on CUMING 132 from Luzon) and *L. ludens* (based on a WALLICH specimen from Singapore). Of these, the first was known only from bathyphylls and sterile acrophylls, the second from sterile and fertile acrophylls, the third only from bathyphylls. HOOKER later included all these, and all true *Lomariopsis* specimens known to him, in *Acrostichum sorbifolium* L. (Spec. Fil. 5, 1864, 242), a species now regarded as confined to tropical America.

METTENIUS was the first to recognize *Teratophyllum* as a genus (1869; posthumous work edited by KUHN); he included in it two species, one in each of the sections here recognized (he included *Stenochlaena*, as a section, in *Lomariopsis*). He included all specimens of *sect. Teratophyllum* in the species *T. aculeatum*.

UNDERWOOD clearly distinguished for the first time between *Stenochlaena*, *Lomariopsis* and *Teratophyllum*, ranking all as sections of *Stenochlaena* (Bull. Torr. Bot. Cl. 33, 1906). But he failed to recognize the great differences between *Stenochlaena* proper and the other sections, as he did not examine spores, scales, or vascular anatomy, and failed to notice the "glands" at the bases of pinnae (including basal reduced ones) in *Stenochlaena*; he also failed to notice that *Teratophyllum* differs from *Lomariopsis* in having all pinnae jointed to the rachis, including the apparently terminal one. UNDERWOOD did not recognize the close relationship between *sect. Teratophyllum* and *sect. Polyseriatae*, remarking only that the latter (as *Arthrobotrya* J.Sm.) appeared to be a valid distinct genus.

The present account is based on that of HOLTUM in Gard. Bull. S. S. 5 (1932) 277-304, with some additional material, especially that recently collected by M. G. PRICE in the Philippines.

#### KEY TO THE SPECIES

##### Based partly on bathyphylls

1. Pinnae of normal bathyphylls (excluding youngest stages) deeply lobed.
2. All pinnae of sterile acrophylls almost sessile.
3. Bathyphyll pinnae to 5 mm wide, pinnules with few segments . . . . . 1. *T. aculeatum*
3. Bathyphyll pinnae to 15 mm wide, pinnules with several segments on each side . . . . . 2. *T. gracile*
2. Lower pinnae of sterile acrophylls with stalks at least 6 mm long, often longer.
4. Pinnae of bathyphylls deeply dissected to linear lobes.
5. Ultimate lobes  $\frac{1}{3}$  mm wide . . . . . 3. *T. leptocarpum*
5. Ultimate lobes much wider . . . . . 6. *T. arthropteroides*
4. Pinnae of bathyphylls less deeply dissected, ultimate lobes almost circular.
6. Fertile pinnae 3 mm wide . . . . . 4. *T. luzonicum*
6. Fertile pinnae 10 mm wide . . . . . 5. *T. rotundifoliatum*
1. Pinnae of bathyphylls (excluding youngest stages) crenate, not deeply lobed.
7. Most pinnae of sterile acrophylls, and of bathyphylls, very asymmetric at base.
8. Largest sterile acrophyll pinnae to 9 by 2 cm; basal acrophyll pinnae with almost symmetric base, almost all other pinnae strongly asymmetric; fertile pinnae  $4\frac{1}{2}$ - $5\frac{1}{2}$  cm long . . . . . 6. *T. arthropteroides*
8. Largest sterile acrophyll pinnae to 15 by 2.8 cm; basal acrophyll pinnae strongly asymmetric at base, distal ones much less so; fertile pinnae 20-24 cm long . . . . . 7. *T. koordersii*
7. All pinnae almost symmetric at base, both acrophylls and bathyphylls.
9. Early stages with lamina on one side of midrib only; small transition bathyphylls with all pinnae on one side of rachis common; fertile pinnae to 20 cm by 3 mm, stalks to 5 mm long . . . . . 8. *T. ludens*
9. Earliest stages with lamina on both sides of midrib; normal and transition bathyphylls all with pinnae on both sides of rachis; fertile pinnae 5-7 cm by 5 mm, stalks 10-15 mm long . . . . . 9. *T. clemensiae*

#### KEY TO THE SPECIES

##### Based on acrophyll characters only

1. Pinnae of sterile acrophylls sessile or nearly so.
2. Sterile pinnae  $2-2\frac{1}{2}$  cm wide . . . . . 1. *T. aculeatum*
2. Sterile pinnae  $1-1\frac{1}{2}$  cm wide . . . . . 1. *T. aculeatum* var. *montanum*
2. Sterile pinnae  $1-1\frac{1}{2}$  cm wide . . . . . 2. *T. gracile*
1. Pinnae of sterile acrophylls, at least lower ones, stalked.
3. Bases of some sterile pinnae conspicuously asymmetric.
4. Stalks of sterile pinnae 3-5 mm long.
5. Basal pinnae with almost symmetric base, base of others strongly asymmetric; fertile pinnae  $4\frac{1}{2}$ - $5\frac{1}{2}$  cm by 5-7 mm . . . . . 6. *T. arthropteroides*
5. Basal pinnae strongly asymmetric at base, bases of upper pinnae less so; fertile pinnae 20-24 cm by  $2\frac{1}{2}$ -3 mm . . . . . 7. *T. koordersii*
4. Stalks of sterile pinnae 5-10 mm long . . . . . 9. *T. clemensiae*
3. Bases of sterile acrophyll pinnae symmetric or nearly so.
6. Pinnae of sterile acrophylls to 20 by 2 cm . . . . . 3. *T. leptocarpum*
6. Pinnae of sterile acrophylls not over 16 cm long, proportionately wider.

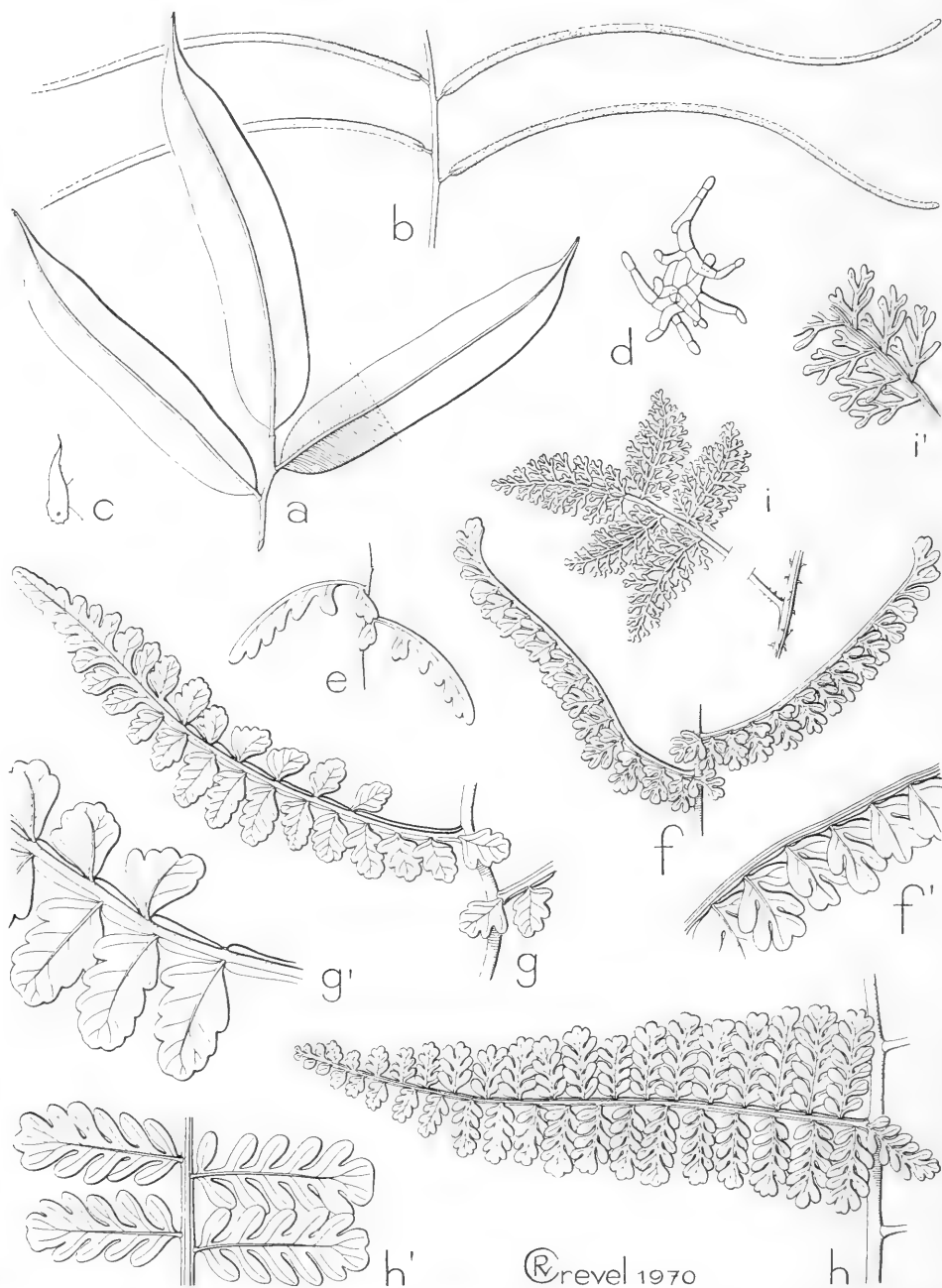


Fig. 4. *Teratophyllum aculeatum* (BL.) METT. ex KUHN. a. Apex of sterile frond,  $\times \frac{2}{3}$ , b. pinnae of fertile frond,  $\times \frac{2}{3}$ , c. scale from rhizome,  $\times 4$ , d. scale from bathyphyll,  $\times 80$ , e. earliest stage, f. dimidiate normal bathyphyll, both nat. size, f'. part of f,  $\times 2$ , g. later stage but pinnae less deeply lobed, h. mature normal bathyphyll, both nat. size, h'. part of h,  $\times 2$ . — *T. gracile* (BL.) HOLTUM. i. Apex of transition bathyphyll, nat. size, i'. part of i,  $\times 2$  (a-b KING's Collector 10005, c-d DONK s.n., e KOSTERMANS 6163, f DONK 73, g MATTHEW s.n., 28 Jan. 1908, h LÖRZING 12257, i WINCKEL 1713).



7. Stalks of sterile pinnae to 5 mm long . . . . . 8. *T. ludens*  
 7. Stalks of sterile pinnae to at least 10 mm long.  
 8. Sides of sterile pinnae parallel except in distal  $\frac{1}{3}$ ; fertile pinnae 3 mm wide . . . . . 4. *T. luzonicum*  
 8. Sides of sterile pinnae not parallel; fertile pinnae c. 10 mm wide . . . . . 5. *T. rotundifoliatum*

1. *Teratophyllum aculeatum* (BL.) METT. ex KUHN, Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 296, excl. *syn. and var. inermis*; HOLTUM, Gard. Bull. S. S. 5 (1932) 284, f. 32, 38–40, 45, pl. 2, 3; *ibid.* 9 (1937) 144; Rev. Fl. Mal. 2 (1954) 473, f. 276; BACKER & POSTH. Varenfl. Java (1939) 151, f. 29; COPEL. Philip. J. Sc. 78 (1949) 400; Fern Fl. Philip. (1960) 270. — *Lomaria aculeata* BL. Enum. Pl. Jav. (1828) 205. — *Stenochlaena aculeata* (BL.) KUNZE, Bot. Zeit. 6 (1848) 142; KARSTEN, Ann. Jard. Bot. Btzg 12 (1895) 143, t. 14, 15; CHRIST, Philip. J. Sc. 2 (1907) Bot. 166, p.p.; v.A.v.R. Handb. (1908) 722, p.p.; Suppl. (1917) 430, excl. *var. crassior*. — *Olfersia aculeata* BL. Fl. Jav. Fil. Suppl. (1883?) t. 96. — *Acrostichum aculeatum* (BL.) RACIB. Fl. Btzg 1 (1898) 53, non LINN., nec DESV. — Type: BLUME s.n., W. Java (L).

*Lomaria polymorpha* ZOLL. & MOR. apud ZOLL. Nat. Geneesk. Arch. N. I. 2 (1845) 204; HASSK. Flora 30 (1847) 319. — Type: ZOLLINGER 2303, Java (BM, BO, L, P).

*Davallia achilleifolia* WALL. ex HOOK. Spec. Fil. 1 (1846) 195, t. 56D; PRESL, Epim. Bot. (1851) 263. — *Acrostichum (Stenochlaena) scandens* HOOK. Spec. Fil. 5 (1864) 250 *quoad* WALLICH 248 *tantum*. — Type: WALLICH 248, Penang (K).

*Lindsaea parishii* BAKER, Syn. Fil. (1867) 109; BEDD. Ferns Br. India (1866) t. 209. — *Stenochlaena palustris* BEDD. Handb. Ferns Br. India (1883) 422 *quoad* F.B.I. t. 209 *tantum*. — Type: PARISH 196, Tenasserim (K). — Fig. 3, 4a–h.

#### 1. *var. aculeatum*.

Fronds on young plants with lamina wholly on one side of midrib, lobed towards the base, later fronds still wholly dimidiate but with lower lobes (to c. 20) separate as  $\pm$  lobed articulated pinnae to 9 by 6 mm (fig. 4f), basal one deflexed across rhizome. Normal bathyphylls sessile, glabrous apart from minute scales when young, commonly c. 9 by 2 cm (to 12 by 5 cm); pinnae to 5 mm wide, in most cases deeply lobed to a winged costa, basal one deflexed and overlapping rhizome, all jointed to rachis except distal ones which merge with apical lamina. Transition bathyphylls variable, some with deeply lobed pinnae (lobes linear), pinnae of others grading to an almost or quite entire condition 12–16 by 5–8 mm with acute or rounded apices. Adult rhizomes 4–6 mm diameter, glabrescent except near apex, bearing scattered spines 1–3 mm long; scales near apex abundant, to 2 mm long, narrow, medium brown, base peltate, edges bearing scattered hairs. Stipes of acrophylls 3–7 cm long, lamina c. 40 cm long with 15 pairs pinnae; sterile pinnae sometimes drying reddish (on midrib or throughout), almost sessile (in Luzon lowest pinnae sometimes stalked 3–5 mm), 9–10(–15) cm long, 2–2 $\frac{1}{2}$ (–3) cm wide, base almost symmetric, of lower pinnae sometimes subtruncate, of others broadly cuneate, edges parallel in basal half, apical half tapering, edges minutely sinuous, texture thin, veins distinct, those near pinna-apex ending freely before reaching margin and bearing on both surfaces very small brown fringed scales (abundant on

young fronds). Fertile pinnae to 15 cm long, hardly 2 mm wide.

Distr. N. to Mergui, throughout *Malesia* except the Lesser Sunda Is.

Ecol. Lowland forest, in moist places; young plants on exposed tree-roots or bases of trunks, climbing to 5 m or more.

2. *var. montanum* HOLTUM, Gard. Bull. S. S. 5 (1932) 289, pl. 1, 4; Rev. Fl. Mal. 2 (1954) 473. — Type: HOLTUM 23364, Malaya (K, S).

Differs from *var. aculeatum* as follows: normal bathyphylls often larger (to 16 cm long) with pinnae to 25 by 6 mm, pinnules to 3 $\frac{1}{2}$  by 2 $\frac{1}{2}$  mm with forked apex and 2–3 narrow lateral lobes; transition bathyphylls more common and larger; sterile pinnae 8–15 mm wide, sometimes drying reddish.

Distr. *Malesia*: Central & North Sumatra, Malay Peninsula.

Ecol. In forest, in valleys at c. 1200–1500 m.

Notes. This is somewhat intermediate between *T. aculeatum* and *T. gracile*. I am not sure that a sharp line can be drawn between *var. aculeatum* and *var. montanum*, but extreme forms of the latter are quite distinct. Most specimens from Taiping Hills have pinnae with narrowly cuneate bases. A specimen from North Sumatra (VAN STEENIS 9724, Mt Kemiri, 1400 m) has bathyphylls intermediate between *var. montanum* and *T. gracile*, and sterile acrophylls like *var. aculeatum*, not narrow as in *T. gracile*.

Aberrant large normal bathyphylls of two distinct types are borne by a few specimens. (a) Fronds 17 cm long, larger pinnae 3 $\frac{1}{2}$  by 1 cm, segments partly webbed as in many transition bathyphylls, upper pinnae gradually smaller and apical lamina not jointed to rachis (KEHDING 3245, Sumatra, P; ZOLLINGER 2303, Java, L, P). (b) Fronds to 14 cm long, largest pinnae 4 by 1.7 cm, pinnules bipinnatifid (AHERN's collector 2695, Luzon, P, US; WARBURG s.n., Java, P).

2. *Teratophyllum gracile* (BL.) HOLTUM, Gard. Bull. S. S. 5 (1932) 291, pl. 5; BACKER & POSTH. Varenfl. Java (1939) 152. — *Lomaria gracilis* BL. En. Pl. Jav. (1828) 205; HOOK. Spec. Fil. 3 (1860) 36. — *Stenochlaena gracilis* KZE, Bot. Zeit. 6 (1848) 142; FÉE, Gen. Fil. (1852) 78; UNDERW. Bull. Torr. Bot. Cl. 33 (1906) 41; v.A.v.R. Handb. Suppl. (1917) 430. — *T. aculeatum* METT. ex KUHN, Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 296, p.p. — *Olfersia gracilis* BL. Fl. Jav. Fil. Suppl. (1883?) t. 96. — *Acrostichum gracile* RACIB. Fl. Btzg 1 (1898) 53. — *Stenochlaena aculeata sensu* v.A.v.R. Handb. (1908) 722, p.p. — Type: BLUME, W. Java (L). — Fig. 4i.

Normal bathyphylls to c. 12 by 4 cm; pinnae to 12 pairs, to 2 $\frac{1}{2}$  by 1 cm, pinnate, tapering to apex; largest pinnules 5 mm long, consisting of 2–3 pairs of very narrow lobes (sometimes forked) joined by a very narrow wing. Transition bathyphylls to 18 cm long; pinnae 12–15 pairs, to 4 by 1 $\frac{1}{2}$  cm, with 12 pairs of pinnules; pinnules pinnatisect, largest with 4 pairs of linear lateral lobes 2 mm long, some

forked, ultimate divisions 0.3 mm wide. *Sterile acrophylls* as *T. aculeatum* but pinnae 1–1½ cm wide, dark red when dry. *Fertile pinnae* to 10 cm long, 1–2 mm wide.

Distr. *Malesia*: West Java.

Ecol. In mountain forest, 1000–1500 m.

**3. *Teratophyllum leptocarpum*** (FÉE) HOLTUM, Gard. Bull. S. S. 9 (1937) 143; COPEL. Fern Fl. Philip. (1960) 271. — *Lomariopsis leptocarpa* FÉE, Hist. Acrost. (1845) t. 29. — *Stenochlaena sorbifolia* ssp. 5 C. CHR. Ind. Fil. (1906) 625, p.p. — Type: CUMING 132, Philippines (orig.?; dupl. in B, BM, US).

*Stenochlaena williamsii* UNDERW. Bull. Torr. Bot. Cl. 33 (1906) 41; CHRIST, Philip. J. Sc. 2 (1907) Bot. 167. — *Stenochlaena gracilis* var. *williamsii* v.A.v.R. Handb. Suppl. (1917) 431. — *T. williamsii* HOLTUM, Gard. Bull. S. S. 5 (1932) 292, pl. 6. — Type: WILLIAMS 684, Mt Mariveles, Luzon (MICH, NY).

*Smallest bathyphylls* seen 2 cm long, pinnate as normal bathyphylls (not wholly dimidiate as in *T. aculeatum*). *Normal bathyphylls* to 6 cm long, pinnate to base on lower side of rachis, not quite to base on upper side; pinnae to 2 by 1.8 cm, with 4–5 pairs of oblique lateral lobes 3–5 mm long, each lobe pinnatisect with 2–4 linear divisions less than ½ mm wide; basal pinnae deflexed, overlapping rhizome. *Transition bathyphylls* to 12 cm long; pinnae to 4 by 1½ cm, lobed as normal bathyphylls but with larger lobes which are more widely spaced; other specimens with lobes of pinnae ± coalescent, pinnae of the extreme form almost sessile with finely crenate edges and broad bases. *Adult rhizome* 4–5 mm Ø, finely thorny. *Sterile acrophylls* with stipes to 20 cm long, lamina 45 cm; pinnae all stalked (stalks of lower ones 6–9 mm), 10–20 cm long, 1–2 cm wide, base slightly unequal, of lower pinnae narrowly cuneate, of upper ones wider, apex long-acuminate, texture rather thin, all parts turning reddish on drying. *Fertile pinnae* to 25 cm long, c. 2 mm wide.

Distr. *Malesia*: Philippines (Luzon, Sibuyan, Samar, Panay, Basilan).

Ecol. In forest, especially near rivers, 100–600 m.

Notes. CHRIST (*l.c.* 1907) refers to specimens having “secondary leaves” with a tendency “to present auricles at the anterior base of the pinnules”; these are young plants of an *Asplenium*, probably *A. epiphyticum* COPEL.

The specimen of CUMING 132 at Paris is *Lomariopsis lineata* and is certainly not the one figured by FÉE.

**4. *Teratophyllum luzonicum*** HOLTUM, Gard. Bull. S. S. 5 (1932) 297, pl. 9; *ibid.* 9 (1937) 142; COPEL. Fern Fl. Philip. (1960) 270. — Type: F. FENIX BS 28272, Apayao Prov., Luzon (BO; dupl. in US).

*Bathyphylls* very like those of *T. rotundifoliatum* (fronds 1½ cm long not dimidiate); transition bathyphylls bipinnate, larger pinnules with one rounded or slightly bifid lobe on acroscopic side. *Adult rhizome* c. 4 mm Ø, somewhat spiny. *Sterile acrophylls* to 60 cm long including stipe, with 8 or more pairs of pinnae; pinnae to 15 by 3 cm, on stalks to 12 mm long, base broadly and slightly unequally cuneate, sides nearly parallel

except in distal third, apex acuminate, texture firm, drying green, veins near midrib 1½–2 mm apart. *Fertile acrophylls* with pinnae to 10 cm long and 3 mm wide, on stalks to 5 mm long.

Distr. *Malesia*: Philippines (Luzon, Palawan, Mindanao).

Ecol. At 600–700 m (JACOBS 7944, Sierra Madre Mts; sterile and fertile acrophylls).

Note. No bathyphylls were collected in association with the original specimens. I subsequently described bathyphylls from Palawan, some of which were associated with sterile acrophylls. There are also transition bathyphylls which in 1937 I thought represented *T. clemensiae*, but now I think it more likely that they also belong to *T. luzonicum*. A final proof can only come from a collection of all stages from the same place. The fertile fronds of *T. luzonicum* and *T. clemensiae* are very different. There are also bathyphylls, without acrophylls, in a collection by LOHER from Mt Mariveles; these agree well with Palawan specimens.

**5. *Teratophyllum rotundifoliatum*** (R. BONAPARTE) HOLTUM, Gard. Bull. S. S. 5 (1932) 294, pl. 7, 8, f. 36, 37, 44; Rev. Fl. Mal. 2 (1954) 474, f. 277. — *Stenochlaena rotundifoliata* R. BONAP. Notes Pterid. 14 (1923) 58. — Type: HOLTUM 9384, G. Lambak, Johore (P; dupl. in SING).

*Stenochlaena aculeata* var. *crassior* v.A.v.R. Bull. Jard. Bot. Btzig II, 23 (1916) 20; Handb. Suppl. (1917) 430. — Type: AJOEB 387, Bencoolen, S. Sumatra (BO). — Fig. 6f–k.

Earliest stage as *T. clemensiae* (not dimidiate as in *T. aculeatum*), the entire fronds soon succeeded by bipinnatifid *normal bathyphylls* up to 8 by 3½ cm, with closely-placed pinnae to 15 by 4 mm with almost circular pinnules, texture firm, usually drying light green. *Transition bathyphylls* to 15 by 6 cm, with up to 20 pairs of pinnae more widely separated than in normal bathyphylls, pinnae to 30 by 4 mm, coriaceous, deeply lobed, lobes c. 2 mm wide, apices rounded, retuse or bilobed. *Adult rhizome* to 8 mm Ø, strongly aculeate, when young densely covered (also young fronds) with small red-brown scales, largest scales seen 7 by 1 mm. *Sterile acrophylls* to 60 cm long including stipe, with 12 pairs of pinnae; all pinnae stalked (stalks of lowest 10–15 mm), commonly to 15 by 3 cm (largest seen 16 by 6 cm), widest below middle, gradually tapering to apex, base rather broadly and almost equally cuneate, coriaceous, drying light green. *Fertile pinnae* to 10 by 1 cm, on stalks to 18 mm long; tips of veins not connected by a submarginal vein.

Distr. *Malesia*: Central & South Sumatra, Malay Peninsula, Borneo.

Ecol. In forest on hillsides (not in swamp-forest), at 150–1000 m.

Note. The only known fertile specimens were collected by WRAY (679, K, SING) in Perak; they are young, with immature sporangia. This species differs from *T. clemensiae* in the broader fertile pinnae without marginal vein, coriaceous sterile pinnae, and in invariably bipinnatifid bathyphylls after the earliest stages. Spores have not been seen.

**6. *Teratophyllum arthropteroides*** (CHRIST) HOLTUM, Gard. Bull. S. S. 5 (1932) 303, pl. 12; COPEL. Fern Fl. Philip. (1960) 271. — *Stenochlaena*

*arthropteroides* CHRIST, Bull. Herb. Boiss. II, 6 (1906) 998; Philip. J. Sc. 2 (1907) Bot. 167; v.A.v.R. Handb. (1908) 719. — Type: LOHER s.n. April 1906, Rio Ampalit, Mt Makiling, Laguna Prov., Luzon (P). — Fig. 5a-c.

On all *bathyphylls* seen (smallest 4 cm long) all pinnae articulate; largest seen 12 cm long with 6 pairs pinnae and stipe nearly 2 cm long; pinnae 10 by 5 to 30 by 12 mm, base narrowly cuneate on basicopic side, broadly on acroscopic, edges crenate, apex blunt; on one collection most pinnae deeply lobed. *Adult rhizome* smooth. *Sterile acrophylls* to 40 cm long; rachis usually reddish when dry; pinnae stalked (stalk of lowest 3–4 mm), 5–9 cm long,  $1\frac{1}{2}$ –2 cm wide, basal pinnae with symmetric base, rest with base very unequal (basicopic narrowly cuneate, acroscopic subtruncate), tapered gradually from widest part near base to acuminate apex, texture thin, edges in most cases distinctly crenulate (one crena to each vein-end). *Fertile fronds* shorter than sterile, pinnae  $4\frac{1}{2}$ –5 $\frac{1}{2}$  cm long, 5–7 mm wide.

Distr. *Malesia*: Philippines (Luzon, Mindanao).

Ecol. In forest, at 250–400 m.

Note. I have not seen the youngest stage of this species. Small transition *bathyphylls* are very like those of *T. koordersii* but thinner, and those seen have a distinct stipe so that basal pinnae do not overlap the rhizome.

7. *Teratophyllum koordersii* HOLTUM, Gard. Bull. S. S. 5 (1932) 301, f. 48, 49, pl. 11. — Type: KOORDERS 17065, Minahassa, N. Celebes (BO). — Fig. 5d.

*Youngest stage*: fronds up to 3 cm long dimidiate with 3 free pinnae all on lower side of rachis (rarely 1 leaflet or lobe on upper side); fronds 3 cm long and larger dimidiate with jointed apical pinna, pinnae 4, to 10 by 3–5 mm, base asymmetric, edges crenate to deeply lobed; *later bathyphylls* with pinnae both sides, on a frond  $7\frac{1}{2}$  cm long apical pinna 20 by 8 mm, lateral pinnae 6 pairs, crenate, decreasing downwards, lowest 13 by 6 mm, base narrowly cuneate on basicopic side, broadly on acroscopic. *Intermediate fronds* 14 cm long, pinnae 8–9 pairs, apical one 3.8 by 1.4 cm, edges almost entire. *Adult rhizome* 4–5 mm  $\varnothing$ , aculeate. *Sterile acrophylls*: stipe  $5\frac{1}{2}$  cm, lamina 45 cm, pinnae 11–12(–20?) pairs, to 15 by 2.8 cm, lowest stalked 5 mm, basicopic base narrowly cuneate, acroscopic broadly rounded, upper pinnae with more symmetric bases. *Fertile fronds*: pinnae 20–24 cm long,  $2\frac{1}{2}$ –3 mm wide, stalks to 5 mm long.

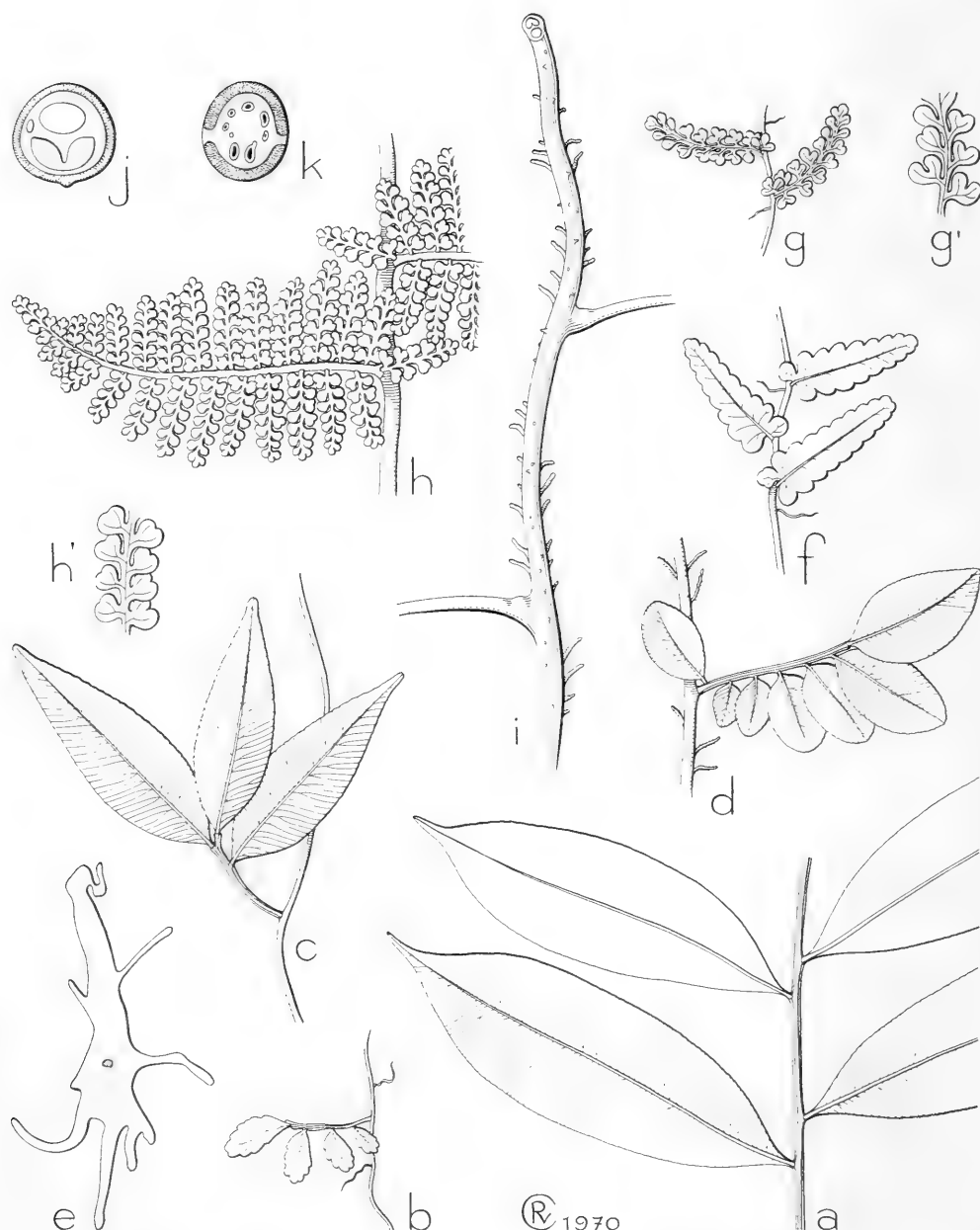
Distr. *Malesia*: N. Celebes, Philippines (Luzon).

Ecol. In moist forest, low altitude.

Note. The above description is taken in part from specimens collected in Luzon by M. G. PRICE (nos 927, 928, 940, 958, 979, 981). These agree closely with the Celebes type and two other speci-



Fig. 5. *Teratophyllum arthropteroides* (CHRIST) HOLTUM. a. Upper pinnae of sterile acrophyll, b. bathyphylls, c. fertile pinnae. — *T. koordersii* HOLTUM. d. Bathyphylls. All  $\times \frac{2}{3}$  (a ELMER 18353, b-c COPELAND PPE 251, d KOORDERS 17064).



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Fig. 6. *Teratophyllum ludens* (FÉE) HOLTUM. a. Pinnae of sterile acrophyll, b. bathyphyll, early stage, c. bathyphyll from creeping rhizome, d. bathyphyll from climbing rhizome, all  $\times \frac{2}{3}$ , e. scale from base of stipe,  $\times 40$ . — *T. rotundifoliatum* (R. BONAP.) HOLTUM. f. Earliest stage, g. second stage, both nat. size, g'. part of g, pinnae not jointed to rachis,  $\times 2$ , h. mature bathyphyll, nat. size, h'. part of a pinna from h,  $\times 2$ , i. rhizome and stipe-bases,  $\times \frac{2}{3}$ , j. CS of rhizome, k. CS of stipe, both  $\times 4$  (a HOLTUM s.n., 13 Oct. 1929, b POLAK 301, d HOLTUM 24632, f-g CORNER 29215, h-i WRAY 679, e, j, k from Gard. Bull. S. S. 5, 1932, 278, 279).

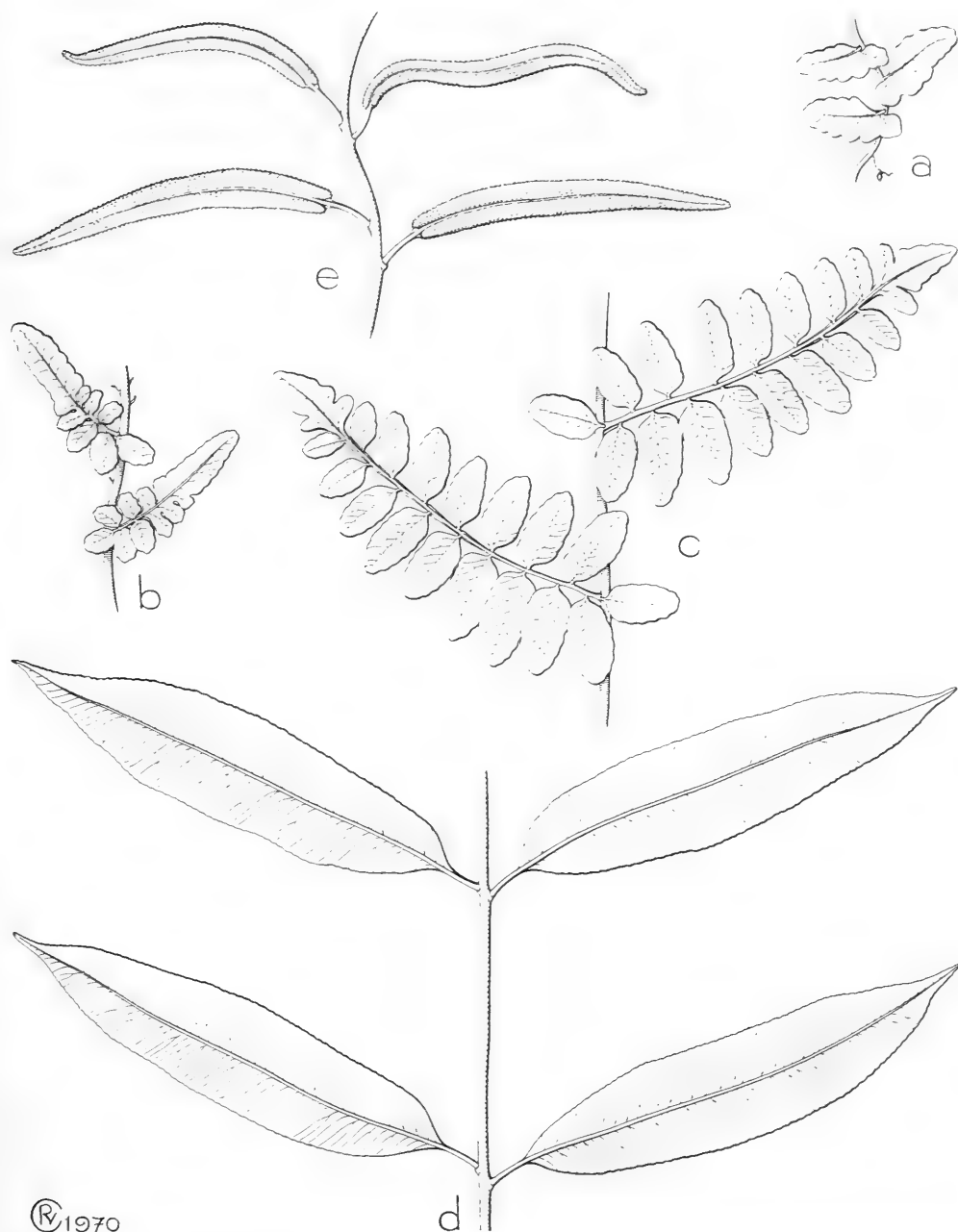


Fig. 7. *Teratophyllum clemensiae* HOLTUM. a. Earliest stage, b. second stage, c. mature bathyphylls, d. pinnae of sterile acrophyll, e. pinnae of fertile acrophyll, all  $\times \frac{2}{3}$  (a CLEMENS 30890, b CLEMENS 50592, c CLEMENS 40560, d-e CLEMENS 31346).

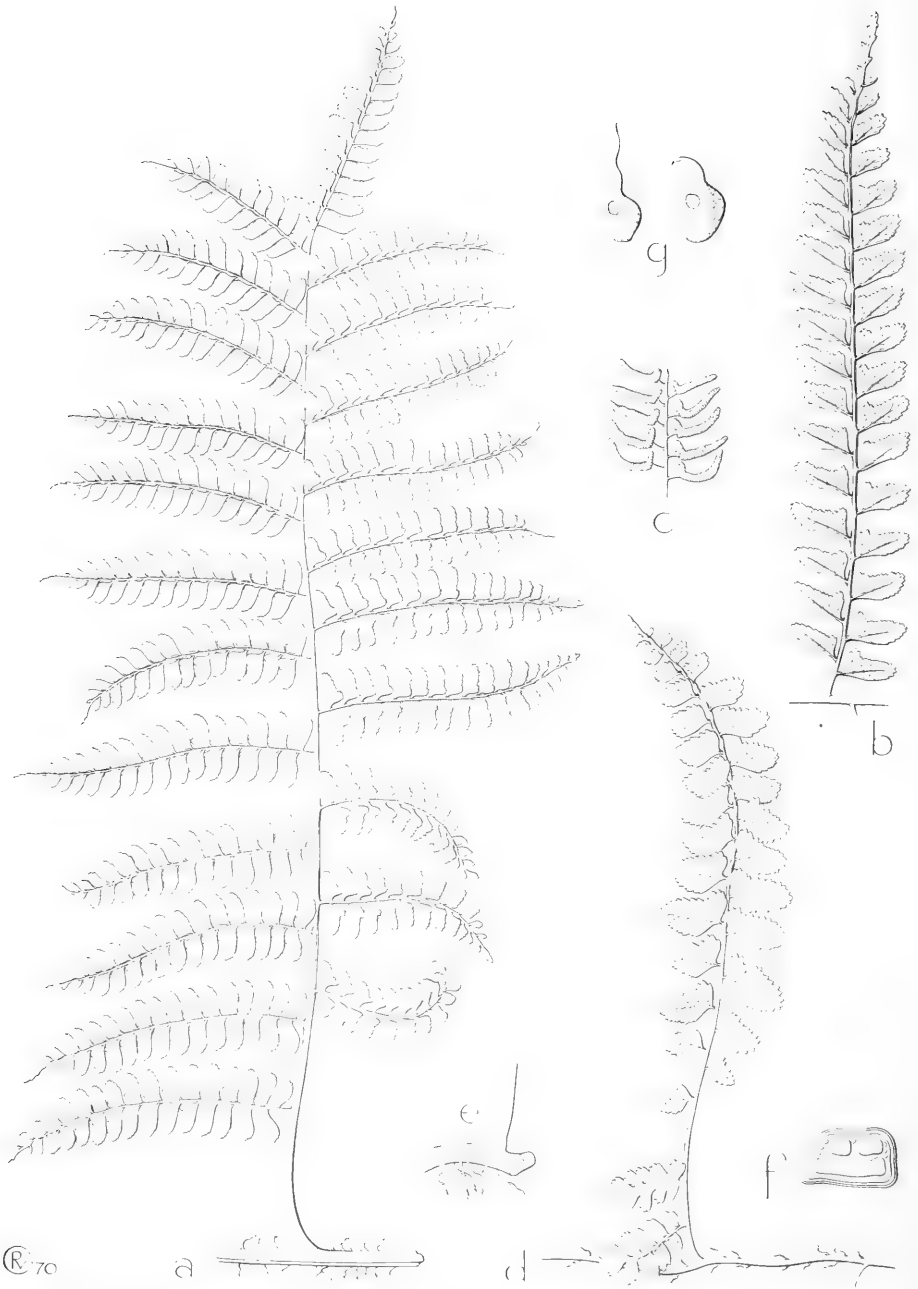


Fig. 8. *Teratophyllum articulatum* (J. Sm. ex FÉE) METT. ex KUHN. a. Sterile acrophyll and rhizome,  $\times \frac{1}{3}$ , b. one pinna of sterile acrophyll, c. fertile pinnules, d. frond of young plant, second stage, basal pinna pinnate, all  $\times \frac{1}{2}$ , e. rhizome with base of stipe,  $\times \frac{1}{3}$ , f. CS of rhizome,  $\times 2$ , g. bullate scales from rachis of acrophyll,  $\times 16$  (a BAMLER in Rosenst. Fil. Novog. exsicc. 122, b, e-g BRASS 12202, c CLEMENS 1073, d EDANO 15165).

mens from the original locality in details of bathyphylls and sterile acrophylls. The fertile specimen (PRICE 927) was found on a high-climbing plant on the edge of forest, not associated with bathyphylls; no fertile fronds are known from Celebes.

**8. *Teratophyllum ludens* (FÉE) HOLTUM**, Gard. Bull. S. S. 5 (1932) 298, pl. 10, f. 35, 46, 47; Rev. Fl. Mal. 2 (1954) 474, f. 278; TAGAWA & IWATSUKI, Act. Phytotax. Geobot. 24 (1970) 62. — *Lomaria ludens* FÉE, Hist. Acrost. (1845) 70, t. 30. — Type: GAUDICHAUD s.n. 1836–37, Singapore (P).

Without name, BEDD. Ferns Br. India (1866) t. 210. — *Stenochlaena sorbifolia* [non (L.) J.S.M.] BEDD. Handb. (1883) 423, *quoad* F.B.I. t. 210 *tantum*. — Type: PARISH s.n. 1863, Mergui (K).

*T. aculeatum* var. *inermis* METT. ex KUHN, Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 297. — Fig. 6a–e.

*Earliest fronds* almost as *T.* — *Transition bathyphylls* on climbing stems  $2\frac{1}{2}$ – $7\frac{1}{2}$  cm long; pinnae 5–9, apical one largest, all on side of rachis towards ground and standing away from supporting tree to which rachis is closely appressed; pinnae 5–30 mm long, broadly elliptic or ovate, apices rounded, edges crenulate distally; later fronds of this type may have 1–2 pinnae on upper side, towards apex; fronds on stems which creep on the ground very variable, bearing (on both sides of rachis) few subequal larger pinnae which are in some cases widest near base, tapering gradually, no basal pinnae overlapping rhizome. *Rhizome* of adult plant c. 3 mm Ø, not aculeate. *Sterile acrophylls* to 50 cm long including stipe; pinnae to 10 pairs, lower ones with stalks to 5 mm long, upper sessile, 7–12 cm long, 2– $4\frac{1}{2}$  cm wide, firm, drying light olive green, almost elliptic or with edges parallel in middle part, narrowed about equally to broadly cuneate base and abruptly short-acuminate apex; veins near midrib 1– $1\frac{1}{2}$  mm apart; edges slightly sinuate, narrowly cartilaginous. *Fertile fronds* as long as sterile; pinnae to 20 cm long, 3 mm wide, on stalks to 5 mm long.

Distr. Peninsular Thailand and Tenasserim (N.

to Mergui); in *Malesia*: Malay Peninsula, Borneo (Sarawak).

Ecol. In fresh-water swamp forest.

**9. *Teratophyllum clemensiae* HOLTUM**, Gard. Bull. S. S. 7 (1934) 262, f. 1–9 (not *ibid.* 9, 1937, 142, which refers to *T. luzonicum*). — Type: CLEMENS 31614, N. Borneo, Mt Kinabalu, Penibukan (SING). — Fig. 7.

*Simple fronds* on very young plants to 3 by  $1\frac{1}{2}$  cm, base on lower side broadly cordate and overlapping rhizome, on upper side cuneate, edges sinuate, apex broadly rounded. Smallest *normal bathyphylls* narrowly deltoid,  $4\frac{1}{2}$  by 2 cm, with 3 or 4 pairs of jointed pinnae below deeply lobed triangular apex, pinnae elliptic, entire, apex rounded, base unequally cuneate; largest fronds to 9 by 4 cm with 9 pairs of free pinnae 2.2 by 1 cm somewhat narrowed to rounded apex. *Transition bathyphylls* of various types, all with entire pinnae shaped nearly as acrophylls; pinnae in some cases all on one side of rachis, usually on both sides, largest fronds to 18 cm long with 10 pairs of pinnae on stalks to 3 mm long, lowest pinna always deflexed, overlapping rhizome. *Rhizome* of adult plant 5 mm Ø with short spines. *Sterile acrophylls* 40–70 cm long including stipe 5–15 cm; pinnae c. 10 pairs, stalks 5–10 mm long, blade 8–15 cm by  $1\frac{1}{2}$ – $2\frac{1}{2}$  cm, broadest near unequally cuneate base, tapering gradually to acuminate apex, texture thin but firm, drying rather light green, veins c. 2 mm apart near midrib, margin narrowly cartilaginous and regular sinuous (prominences at vein-ends). *Fertile fronds* with 10–12 pairs of pinnae on stalks 10–15 mm long; each pinna 5–7 cm long, 5 mm wide, veins uniting in a submarginal vein.

Distr. *Malesia*: Borneo (Sarawak & Sabah).

Ecol. In forest, at 600–1500 m.

NOTE. In 1937 I suggested that transition bathyphylls from Palawan (MERRILL 862, US) were referable to this species. I now think that they are more likely to belong to *T. luzonicum*, as their pinnae have a more oblong shape and veins closer together than in bathyphylls of this size in *T. clemensiae*.

## 2. Section Polyseriatae

HOLTUM, Gard. Bull. S. S. 9 (1938) 356; Blumea 14 (1966) 216–218. — *Polybotrya sensu* FÉE, Hist. Acrost. (1845) 12, 72, p.p. — *Acrostichum* sect. *Polybotrya* HOOK. Spec. Fil. 5 (1864) 247. — *Teratophyllum* METT. ex KUHN, Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 297, p.p. — *Arthrobotrya* J.S.M. Hist. Fil. (1875) 141; UNDERW. Bull. Torr. Bot. Cl. 33 (1906) 40; COPEL. Gen. Fil. (1947) 118; Fern Fl. Philip. (1960) 272. — *Polybotrya* sect. *Teratophyllum* CHRIST, Farnkr. Erde (1897) 42; DIELS in E. & P. Nat. Pfl. Fam. 1, 4 (1899) 198. — *Polybotrya* sect. *Arthrobotrya* v.A.v.R. Handb. (1908) 725. — *Lomagramma sensu* COPEL. Philip. J. Sc. 3 (1908) Bot. 32, p.p.; C. CHR. Ind. Fil. Suppl. 1 (1913); v.A.v.R. Handb. Suppl. (1917) 437.

Type species: *Polybotrya articulata* J.S.M. ex FÉE.

Distribution. *Malesia*: Celebes, Moluccas, Philippines, New Guinea; eastwards to Tahiti, south-eastwards to Queensland and New Caledonia; 3 spp.

Vegetative morphology. See HOLTUM, l.c. Acrophylls of the Malesian species *T. articulatum* are always bipinnate; in *T. wilkesianum* (BRACK.) HOLTUM (New Caledonia to Tahiti) some acrophylls (both

sterile and fertile) are simply pinnate, and not infrequently one frond is partly pinnate, partly bipinnate; in *T. brightiae* (F.v.M.) HOLTUM (N. Queensland) all acrophylls are simply pinnate. Detached simply pinnate acrophylls, whether sterile or fertile, are indistinguishable from such fronds of *sect. Teratophyllum*. The youngest stages of bathyphylls are inadequately known; one specimen of a young plant of *T. articulatum* has bipinnate fronds with deflexed basal pinna, not differing in any significant character from *sect. Teratophyllum*. The bathyphylls of *T. brightiae* are always simply pinnate (HOLTUM, 1938, pl. 28) but the earliest stage is not known. Vascular anatomy of adult rhizomes is very like that in *Lomariopsis*, but the bases of stipes are somewhat swollen and rather imperfectly jointed, not gradually decurrent as in *Lomariopsis*. Fertile leaflets have an additional vascular supply for the sporangia, as in *sect. Teratophyllum*.

**Taxonomy.** As indicated in the synonymy, *T. articulatum* was first included in the genus *Polybotrya* HUMB. & BONPL. and transferred to the new genus *Teratophyllum* by KUHN in 1869. JOHN SMITH established a new genus *Arthrobotrya* for it in 1875, but CHRIST and DIELS retained it in *Polybotrya sect. Teratophyllum*, in which they did not include the species here placed in *Teratophyllum sect. Teratophyllum*. The second species of the section, *T. wilkesianum*, was described in *Polybotrya* by BRACKENRIDGE in 1854, the third, *T. brightiae*, by F. VON MUELLER in *Acrostichum* in 1870. UNDERWOOD places *T. brightiae* (as *Stenochlaena hügelii*) in *Stenochlaena sect. Lomariopsis*, remarking that *T. articulatum* belonged to a distinct genus *Arthrobotrya*. In his early work on Philippine ferns, COPELAND transferred *T. articulatum* to the genus *Lomagramma* because of its similarity to *L. polyphylla* (with which it had been associated by DIELS, who placed the simple pinnate *Lomagramma* species in *Gymnopteris*). In *Genera Filicum* (1947) COPELAND revived the genus *Arthrobotrya*; but he avoided consideration of the species *T. brightiae*, which has always simple acrophylls. The only clearly definable character distinguishing the two sections of *Teratophyllum*, as here presented, is the polyseriate or biseriate arrangement of fronds on the upper surface of the rhizome, with accompanying difference of vascular structure; this does not appear to me to warrant generic separation of the two.

**10. *Teratophyllum articulatum*** (J.Sm. ex FÉE) METT. ex KUHN, Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 297; HOLTUM, Gard. Bull. S. S. 9 (1938) 356. — *Polybotrya articulata* J.Sm. ex FÉE, Hist. Acrost. (1845) 74, t. 37; CHRIST, Farnkr. Erde (1897) 42, f. 101; DIELS in E. & P. Nat. Pfl. Fam. 1, 4 (1899) 198; COPEL. Polypod. Philip. (1905) 40; HOLTUM, Blumea 14 (1966) 217. — *Acrostichum* (*sect. Polybotrya*) *articulatum* HOOK. Spec. Fil. 5 (1864) 247. — *Arthrobotrya articulata* J.Sm. Hist. Fil. (1875) 141; COPEL. Gen. Fil. (1947) 118; Philip. J. Sc. 78 (1949) 401; Fern Fl. Philip. (1960) 272. — *Lomagramma articulata* COPEL. Philip. J. Sc. 3 (1908) Bot. 32; v.A.v.R. Handb. Suppl. (1917) 437. — Type: CUMING 296, Luzon (BM, GH, K, P). — *Lomagramma bipinnata* COPEL. Philip. J. Sc. 11 (1916) Bot. 41; v.A.v.R. Handb. Suppl. (1917) 438. — Type: RAMOS BS 17515, Samar (MICH). — Fig. 8.

*Youngest stage* with simply pinnate fronds to 9 cm long with deeply crenate articulate pinnae 8 by 4–5 mm, apex of frond a narrow lobed lamina not articulate; next stage with basal pinnae pinnate and in some cases deflexed across rhizome, upper simple pinnae to 22 by 11 mm, pinnules of basal pinnae to 6 by 4 mm; later fully bipinnate fronds 2-ranked on slender rhizome are like acrophylls but smaller. *Adult rhizome* 7–8 mm or more wide, smooth. *Sterile acrophylls* with stipes 10–20 cm, lamina to 60 cm long, bipinnate; pinnae 15–24 cm long, articulate to rachis, pinnate with to 20 or more pairs of articulate pinnules which grade into the

small widely-spaced lobes of a narrow apical lamina; pinna-rachis winged throughout; pinnules sessile or nearly so, base very asymmetric, narrowly cuneate basiscopically, very broadly cuneate and usually with a well-developed auricle acrosopically, edges crenate, apex rounded, largest pinnules 15–25 mm long, 6–8 mm wide above auricle; brown bullate scales on lower surface of costa. *Fertile fronds* somewhat smaller than sterile; pinnules distinctly stalked, 7–15 mm long, c. 2 mm wide when dry, distinctly auricled.

**Distr. Malesia:** Celebes (SW. & NE.), Moluccas (Ceram, Halmahera), Philippines (Luzon, Leyte, Samar, Mindanao), New Guinea, Solomon Islands.

**Notes.** This species is distinguished from *T. wilkesianum* (New Caledonia, Fiji, Samoa, Tahiti) by the auricled acrosopic base of its pinnules, and by the complete absence of simply pinnate acrophylls; also apparently by the brown bullate scales of the lower surface of pinnules.

Two SARASIN specimens from N. Celebes match *T. wilkesianum* from New Caledonia very closely in shape of leaflets, but they have the scales characteristic of *T. articulatum*. It seems possible that these specimens represent a distinct local form of the species. COPELAND (1960: 273) refers to a specimen of his own from Mindanao which resembles *T. wilkesianum*; this has rather small fronds with deeply incised small leaflets which are very asymmetric at the base and seem to me much less like *T. wilkesianum* than the Celebes specimens.

#### 4. LOMAGRAMMA

J.Sm. in Hook. J. Bot. 3 (1841) 402, *nom. nud.*; in Hook. Gen. Fil. (1842) t. 98; BEDD. Handb. Ferns Br. India Suppl. (1892) 105; C.CHR. Ind. Fil. Suppl. 1 (1913) 49 (*p.p.*), 118; v.A.v.R. Handb. Suppl. (1917) 436, *excl. L. articulata et bipinnata*; COPEL. Univ. Cal. Publ. Bot. 16 (1929) 76, *excl. L. articulata*; HOLTUM, Gard. Bull. S. S. 9 (1937) 190–221; Rev. Fl. Mal. 2 (1954) 477; COPEL. Fern Fl. Philip.



(1960) 273–275; HOLTUM, *Blumea* 14 (1966) 221–223. — *Leptochilus* KAULF. *p.p.* BL. En. Pl. Jav. (1828) 206; C. CHR. Bot. Tidsskr. 26 (1904) 283; Ind. Fil. (1905) xxvi; v.A.v.R. Handb. (1908) 746. — *Cheilolepton* FÉE, Hist. Acrost. (1845) 19. — *Neurocallis* FÉE *p.p.* PRESL, Epim. Bot. (1851) 177. — *Chorizopteris* MOORE, Gard. Chron. Agr. Gaz. (1855) 854. — *Neurocallis* sect. *Cheilolepton* MOORE, Ind. Fil. (1857) xix. — *Acrostichum* sect. *Chrysodium* (FÉE) HOOK. Spec. Fil. 5 (1864) 268, *p.p.*; BAKER, Syn. Fil. (1868) 423. — *Polybotrya* HUMB. & BONPL. sect. *Lomagramma* KUHN, Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 295. — *Gymnopteris* BERNH. *p.p.* DIELS in E. & P. Nat. Pfl. Fam. 1, 4 (1899) 198. — **Fig. 9-14.**

*Rhizome* of adult plant climbing tree-trunks, broad, bearing 3–5 rows of fronds on dorsal surface (except *L. brassii* which has 2 rows), 3 or more fronds often attached close together, such groups rather widely separated; young parts of rhizome and young fronds densely scaly; scales peltate, smaller ones always clathrate, larger ones often with a central or basal area of uniformly thin-walled cells with darker contents; vascular system as in *Lomariopsis*. *Stipes* gradually decurrent at their bases to ridges on rhizome, the pale linear aerophore on each side of a stipe decurrent also. *Young plants* with slender rhizome bearing only 2 longitudinal rows of fronds, creeping on rocks or on the ground; fronds widely separated, of distinctive form (bathyphylls). *Fronds* simply pinnate (bipinnate in *L. polyphylla* BRACK., New Hebrides to Fiji, also recently discovered in *L. cordipinna* HOLTUM in Fiji) with all pinnae, apical one included, jointed to rachis; scales on fronds clathrate, smaller ones bullate at base; veins forming a uniform network of 3 or more rows of oblique areoles without included veinlets and without main veins; edges of sterile pinnae entire or crenate. *Fertile fronds* with pinnae narrower than sterile, covered beneath with sporangia, venation as sterile but areoles fewer; slender-stalked paraphyses present, about as long as sporangia, their apices dilated, irregular in shape, formed of 8–10 cells with thick lateral walls as small scales on other parts of plant. *Spores* lacking perispore.

Type species: *L. pteroides* J.Sm.

*Distribution.* Assam to S. China and Thailand; throughout Malesia except the eastern Lesser Sunda Is.; Solomon and New Hebrides to Tahiti; about 18 spp. (one species in tropical America has been included by CHING, but its status is doubtful; see p. 278, 289).

*Ecology.* In all cases where young plants have been observed, they grow on wet rocky banks of small streams in high forest, at altitudes from sea level to 1500 m. Their slender rhizomes, bearing erect fronds, are wide-creeping, extending into the forest away from the stream until they meet tree-trunks, up which they climb vertically, attached by roots, to 10 m or more (fig. 9), developing a much thicker rhizome and larger horizontal or drooping fronds. Fertile fronds are produced on the upper parts of climbing rhizomes, probably in response to drier conditions; the only occasion on which I have seen fertile fronds on *L. sumatrana* in Malaya was on a plant which had recently been exposed by felling of neighbouring trees. *L. sinuata* in New Guinea tolerates more exposed conditions than *L. sumatrana* and can continue to grow after partial clearing of forest. Spores are probably short-lived; this may limit their dispersal range.

*Vegetative morphology.* In morphology and anatomy of rhizome *Lomagramma* is closely similar to *Lomariopsis*, but scales are wholly or partly clathrate. Young plants of all species have simply pinnate fronds with jointed pinnae and a lobed apical lamina continuous with the rachis. Sooner or later fronds are produced in which this lobed apex is aborted (a rudiment can sometimes be seen) and its place taken by a pinna which is jointed at its base. In some species this change takes place only when the plant is large enough to produce fronds with many pinnae (see special key below); in others the apical lamina is lacking from a much earlier stage when fronds have few pairs of pinnae. I have observed this distinction constantly between the two species in Malaya which I have seen many times in their native habitat. Unfortunately young stages have not been well collected for most species, or collections have consisted only of young stages without association of the adult stage. The venation of sterile acrophyll pinnae is very constant in all cases; that of fertile pinnae has small areoles, in number varying with width of pinnae. There is not a great range in shape and size of pinnae, whether sterile or fertile, and I have not found it possible to construct a complete key based only on sterile fronds (which are commonest in herbaria).

Gametophyte. See p. 258 *supra*.

Cytology. The only observations are by ROY and MANTON on root-tips of plants of *L. sinuata* and *L. melanolepis* sent by me from New Guinea and cultivated at Kew; both cases showed  $2n = 82$ .

Taxonomy. JOHN SMITH based the genus on the peculiar condition of the fertile pinnae of *L. pteroides*, which have the sporangia confined to a marginal band with a narrow sterile area between this and the midrib, at least near the base of a pinna. In 1845 FÉE based the genus *Cheilelepton* on *L. lomarioides* (of which he published a good figure) but did not refer to *L. pteroides*, presumably because he thought it not to be acrostichoid, though J. SMITH had noted its possible identity with *L. lomarioides* (which he had not seen). MOORE also, in his scheme of classification (1857) placed *Lomagramma* (limited to *L. pteroides*) in a group of genera quite distinct from *Cheilelepton*, which latter he united with *Neurocallis* (a near ally of *Acrostichum s.str.*) because of similarity of venation. HOOKER (1864) stated that *L. pteroides* was only an abnormal form of *L. lomarioides*, and regarded specimens from Samoa (*L. cordipinna* HOLTUM) as belonging to the same species. He placed *L. lomarioides* near *Acrostichum s.str.* and *Neurocallis* on account of their common characters of acrostichoid fertile pinnae and reticulate venation. KUHN (1869) placed *Lomagramma* as a section of *Polybotrya*. In his last work BEDDOME (1892) recognized *Lomagramma* once more as a distinct genus, and described a new species (*L. perakensis*); but DIELS (1899) relegated it again to a confused mixture of acrostichoid ferns of very diverse affinity in *Gymnopteris*. CHRISTENSEN (1904) placed *Lomagramma* as a section of *Leptochilus* (another section being *Bolbitis*) but later recognized it as a distinct genus.

As noted in the introductory statement on this group of genera, I regard *Lomagramma* as closely related to *Bolbitis*. *Lomagramma* differs from *Bolbitis* constantly in Malesia in the following characters: high-climbing rhizome, articulate pinnae, reticulate venation without main veins or included free veinlets and thin-walled spores lacking perispore. In tropical America there is a species of *Bolbitis* which is very near *Lomagramma* in venation, *B. serratifolia* (KAULF.) CHING. The species originally named *Polypodium guianense* AUBL. has been placed in *Lomagramma* by CHING and in *Bolbitis* by KRAMER. It has *Lomagramma*-like bathyphylls, a high-climbing rhizome and articulated pinnae. In my view it is not closely related to Malesian *Lomagramma* (see p. 289). There is considerable variation in the pattern of venation in *Bolbitis*, and in Malesia also are species which have a reticulate venation lacking free included veinlets, though none lack main lateral veins. Bathyphyll pinnae of *Lomagramma* have a toothed margin much as some *Bolbitis* spp. If one has a small detached bathyphyll from a young plant of *Lomagramma*, the only character by which one can be sure it is not *Bolbitis* is the jointed pinnae.

COPELAND wrote (Fern Fl. Philip. 1960, 275) "at present it does not seem to me quite impossible that our specimens (of *Lomagramma*) represent a single widely variable species". I am sure that distinct species exist, but admit that in New Guinea I have found their delimitation difficult. More field work is necessary before a better arrangement can be established; information on all stages of development, gained separately in individual localities, is needed. It is possible that hybrids exist, as in *Bolbitis*.

Keys. As noted above, the most characteristic parts of a *Lomagramma* species are often the bathyphylls and the fertile fronds. I find it impossible to construct a satisfactory key which does not include these characters, and they are used in the main key which follows. Incomplete keys, based only on one of the three different kinds of fronds, are also given, as a help to the identification of incomplete specimens.

#### KEY TO THE SPECIES

1. Mature plants with broad rhizomes bearing 3 or more rows of fronds; sterile acrophyll pinnae not toothed throughout.
2. Sterile acrophyll pinnae very firm, veins indistinct, not prominent on upper surface.
3. Sterile acrophyll and bathyphyll pinnae entire or at most sinuate towards apices; fertile pinnae to 20 cm long.
  4. Sterile acrophyll pinnae to  $12\frac{1}{2}$  by  $1\frac{1}{2}$  cm, base broadly cuneate to truncate and sometimes slightly auricled on acrosopic side; fertile pinnae to 2 mm wide . . . . . 1. *L. lomarioides*
  4. Sterile acrophyll pinnae to 25 by  $2\frac{1}{2}$  cm, base narrowly cuneate; fertile pinnae 3–5 mm wide . . . . . 2. *L. perakensis*
3. Sterile acrophyll pinnae distinctly toothed towards apex; fertile pinnae to 10 cm long.
  5. Fertile pinnae 3 mm wide, stalks to 5 mm long . . . . . 3. *L. merrillii*
  5. Fertile pinnae 8 mm wide, sessile . . . . . 4. *L. novoguineensis*
2. Sterile acrophyll pinnae with veins distinct and  $\pm$  prominent on upper surface.
  6. Fertile pinnae  $4\frac{1}{2}$  by 0.8 cm with rounded apices; sterile pinnae 1.3 cm wide, toothed towards apices . . . . . 4. *L. novoguineensis*
  6. Fertile pinnae narrower or much longer; sterile wider or with entire edges.
    7. Sterile acrophyll pinnae to 8 mm wide, entire . . . . . 5. *L. angustipinna*
    7. Sterile acrophyll pinnae more than 1 cm wide, narrower ones often toothed towards apices.
    8. Bathyphylls with narrow lobed apical lamina continuous with rachis on fronds with 20 pairs of pinnae.
      9. Sterile acrophyll pinnae commonly 1.2–1.8 cm wide, broad and almost symmetrical at base; fertile pinnae dilated and partly sterile at base . . . . . 6. *L. pteroides*
      9. Sterile acrophyll pinnae commonly 2 cm or more wide, asymmetric at base; fertile pinnae not dilated at base . . . . . 7. *L. sumatrana*
    8. Bathyphylls with jointed apical pinna on fronds with few pairs of pinnae.

10. Base of lower sterile acrophyll pinnae broadly rounded or subcordate on both sides.
11. Pinnae firm and opaque, veins hardly prominent; scales on rhizome distinctly clathrate . . . . . 8. *L. brooksii*
11. Pinnae thin, veins prominent; scales on rhizome not clathrate except near their tips . . . . . 9. *L. leucolepis*
10. Base of lower sterile acrophyll pinnae distinctly asymmetric, narrower on basiscopic side, acroscopic side usually broadly cuneate.
12. Fertile pinnae 5–8 mm wide; sterile pinnae 2–4 cm wide . . . . . 10. *L. sinuata*
12. Fertile pinnae not over 4 mm wide, sterile mostly not over 2 cm wide.
13. Suprabasal sterile acrophyll pinnae rounded on basiscopic side at base . . . . . 11. *L. copelandii*
13. Suprabasal acrophyll pinnae narrowly cuneate on basiscopic side at base . . . . . 12. *L. melanolepis*
1. Mature plants with slender rhizome bearing 2 rows of fronds; sterile pinnae with edges strongly toothed throughout . . . . . 13. *L. brassii*

## KEY BASED ON STERILE ACROPHYLLS

1. Pinnae very firm and opaque, veins not or slightly prominent.
2. Pinnae to 26 cm long, base cuneate both sides . . . . . 2. *L. perakensis*
2. Pinnae not over 15 cm long.
3. Pinnae entire.
4. Lower pinnae almost equally subcordate at base . . . . . 8. *L. brooksii*
4. Lower pinnae unequal at base, acroscopically broadly truncate or slightly auricled . . . . . 1. *L. lomarioides*
3. Pinnae distinctly toothed towards apices . . . . . 3. *L. merrillii*
4. *L. novoguineensis*
1. Pinnae thinner, usually translucent when dry, veins always distinctly prominent.
5. Largest pinnae not over 1½ cm wide.
6. Largest pinnae 10 by 0.8 cm, entire . . . . . 5. *L. angustipinna*
6. Largest pinnae usually wider, strongly toothed. . . . . 13. *L. brassii*
5. Largest pinnae wider.
7. Lower pinnae with basiscopic base broadly rounded to subcordate . . . . . 6. *L. pteroides*
8. *L. brooksii*
9. *L. leucolepis*
7. Lower pinnae with basiscopic base cuneate or narrowly rounded.
8. Basiscopic base narrowly cuneate.
9. Pinnae 2–4 cm wide, to 20 cm long . . . . . 10. *L. sinuata*
9. Pinnae rarely over 2 cm wide, shorter . . . . . 12. *L. melanolepis*
8. Basiscopic base rounded . . . . . 7. *L. sumatrana*
10. *L. sinuata f. papuana*
11. *L. copelandii*

## KEY BASED ON BATHYPHYLLS ONLY

1. Apical lamina lobed and continuous with rachis on fronds with 15–20 pairs of pinnae.
2. Pinnae entire or with slightly sinuate edges . . . . . 1. *L. lomarioides*
2. Pinnae distinctly toothed, at least towards apices.
3. Pinnae blunt-tipped, bluntly toothed, drying reddish . . . . . 6. *L. pteroides*
3. Pinnae acute (except youngest stages), acutely toothed, not drying reddish.
4. Pinnae falcate, toothed near apices only . . . . . 8. *L. brooksii*
4. Pinnae toothed throughout.
5. Pinnae to 5 by 1.2 cm . . . . . 7. *L. sumatrana*
5. Pinnae shorter and narrower . . . . . 4. *L. novoguineensis*
1. Apical lamina replaced by a pinna jointed to rachis on fronds with few pairs of pinnae.
6. Pinnae entire or with slightly sinuate edges . . . . . 2. *L. perakensis*
6. Pinnae distinctly toothed . . . . . 3. *L. merrillii*
10. *L. sinuata*
11. *L. copelandii*
12. *L. melanolepis*
13. *L. brassii*
- Bathyphyll characters not known . . . . . 5. *L. angustipinna*
9. *L. leucolepis*

1. *Lomagramma lomarioides* (BL.) J.S.M. Hist. Fil. (1875) 143; BEDD. Handb. Suppl. (1892) 106, p.p.; v.A.v.R. Handb. Suppl. (1917) 438, p.p.; HOLTUM, Gard. Bull. S. S. 9 (1937) 204, pl. 12, 13; BACKER & POSTH. Varenfl. Java (1939) 153; COPEL. Philip. J. Sc. 78 (1949) 401. — *Leptochilus lomarioides* BL.

En. Pl. Jav. (1828) 206; v.A.v.R. Handb. (1908) 746, p.p. — *Cheilolepton blumeianum* FÉE, Hist. Acrost. (1845) 89, t. 51. — *Acrostichum blumeianum* (FÉE) HOOK. Spec. Fil. 5 (1864) 268, p.p.; BAKER, Syn. Fil. (1868) 423, p.p.; RACIB. Fl. Btzg 1 (1898) 55. — *Polybotrya lomarioides* (BL.) KUHN, Ann.



Fig. 9. *Lomagramma perakensis* BEDD. Acrophylls, on tree in forest at Cameron Highlands, Malaya (Photogr. R. E. HOLTUM).

Mus. Bot. Lugd.-Bat. 4 (1869) 295. — Type: BLUME *s.n.*, Salak, Java (L).

*L. abscondita* v.A.v.R. Bull. Jard. Bot. Btzig II, 11 (1913) 16; Handb. Suppl. (1917) 439; Bull. Jard. Bot. Btzig III, 2 (1920) 159. — Type: RACIBORSKI *s.n.*, G. Salak (BO).

*Rhizome* scales thin, to 2 mm wide, strongly clathrate with brown cell-walls. *Bathyphylls* with pinnae to 25 pairs and apical lamina continuous with rachis; largest pinnae 5 by 1 cm, acroscopic base broadly cuneate to subcordate, basiscopic narrowly rounded, edges quite entire or slightly sinuate, apex acuminate, falcate, texture firm, veins hardly visible on upper surface, slightly prominent beneath. *Sterile acrophylls*: stipe to 20 cm, frond to 100 cm long, middle pinnae largest, lowest gradually reduced and more widely spaced; largest pinnae  $12\frac{1}{2}$  by  $1\frac{1}{2}$  cm, acroscopic base broadly cuneate to truncate and sometimes slightly auricled, basiscopic narrowly rounded; texture of old fronds very firm, veins hardly visible on upper surface, somewhat prominent below but rather broad; edges entire, often inrolled when dried, apex acuminate, falcate. *Fertile fronds*: pinnae sessile, to at least 18 cm long, 1–2 mm wide.

Distr. *Malesia*: Java, Lesser Sunda Is. (Bali).

Ecol. In forest at 750–1500 m.

Note. *Bathyphylls* have not often been collected; a good example is PALMER & BRYANT 1190, Tjibodas (US).

**2. *Lomagramma perakensis* BEDD.** Handb. Suppl. (1892) 107; v.A.v.R. Handb. Suppl. (1917) 439; HOLTUM, Gard. Bull. S. S. 9 (1937) 210, pl. 16; Rev. Fl. Mal. 2 (1954) 478, f. 281. — *Leptochilus perakensis* (BEDD.) C.CHR. Ind. Fil. (1906) 387; v.A.v.R. Handb. (1908) 747. — Type: J. DAY *s.n.*, Perak (K). — Fig. 9, 11f–g.

*Rhizome* scales to 10 by  $1\frac{1}{2}$  mm, dull brown, distinctly clathrate. *Bathyphylls* as small as 5 cm long with apical pinna jointed to rachis; stipes of largest bathyphylls 25 cm long, lamina c. 30 by 14 cm, pinnae 10–15 pairs oblique to rachis, sessile, edges entire or somewhat sinuous, not toothed, largest 7 by 1.2 cm, texture firm, veins not prominent. *Sterile acrophylls*: stipe to 40 cm, fronds to 125 cm long; pinnae oblique, largest 26 by  $2\frac{1}{2}$  cm, subsessile, base rather narrowly unequally cuneate, edges slightly undulate, not toothed, apex falcate acuminate, texture very firm, veins hardly prominent on either surface. *Fertile fronds*: pinnae commonly to 20 cm long (largest seen 40 cm), 3–5 mm wide, on stalks 3–7 mm long.

Distr. *Malesia*: Sumatra, Malay Peninsula (north to Pattani in S. peninsular Thailand).

Ecol. In valleys in mountain forest, at 600–1400 m.

**3. *Lomagramma merrillii* HOLTUM**, Gard. Bull. S. S. 9 (1937) 208, pl. 14; COPEL. Fern Fl. Philip. (1960) 274. — Type: MERRILL 8282, Mindanao, Zamboanga District (M, destroyed).

*Bathyphylls*: pinnae to c. 10 pairs, to 3 by 1.3 cm, acroscopic bases broadly, basiscopic narrowly, crenate, edges acutely toothed, apex acute; apical pinna largest and articulate, c. 6 by 1.4 cm. *Sterile acrophylls*: stipe to 15 cm, frond to 45 cm long; upper pinnae largest, c. 9 by 1.7 cm, falcate, base unequally cuneate, edges finely and irregularly

toothed towards apex, subcoriaceous, veins not conspicuous. *Fertile pinnae* (seen only in immature condition) to 9 cm long, 3 mm wide, apex acute (?), stalks to 5 mm long.

Distr. *Malesia*: Philippines (Mindanao, Negros).

Ecol. In forest, at 1500 m.

Note. In 1937 I saw the type specimen from the Manila herbarium; this and the CLEMENS specimen also cited with the original description are now lost, and I do not know of any duplicates. The only post-war collections consist of bathyphylls.

**4. *Lomagramma novoguineensis* (BRAUSE) C.CHR.** Ind. Fil. Suppl. 3 (1934) 124; HOLTUM, Gard. Bull. S. S. 9 (1937) 208, pl. 15; COPEL. Philip. J. Sc. 78 (1949) 401. — *Leptochilus novoguineensis* BRAUSE, Bot. Jahrb. 56 (1920) 117. — Type: LEDERMANN 9524, NE. New Guinea, Sepik River, Etappenberg, 850 m (B). — Fig. 10a.

*Bathyphylls* with apex continuous with rachis on fronds with many pinnae. *Sterile acrophylls*: pinnae to 11 by 1.3 cm, base subequally rounded to truncate (lowest pinnae with base narrower on basiscopic side), edges serrate towards apex, texture very firm, veins at most slightly prominent; bullate acuminate scales abundant on lower surface of costae and veins; apex of frond sometimes a narrow lobed lamina continuous with rachis. *Fertile pinnae* sessile, to  $4\frac{1}{2}$  by 0.8 cm, apex rounded.

Distr. *Malesia*: New Guinea (W.–E.).

Note. Only two collections of acrophylls and fertile fronds are known, the second being from 50 m alt. in western New Guinea. A third collection, of bathyphylls only, may also represent this species (WOMERSLEY & MILLAR NGF 8571, Western Highlands of NE. New Guinea, 700 m). The fronds of this have up to 40 pairs of closely-placed pinnae below the narrow lobed apex; the larger pinnae resemble the upper pinnae of the type of *L. novoguineensis*. A poor specimen collected by CLEMENS (8083A, Sattelberg, 1000 m, B) may also represent this species, but fertile fronds are young, not fully expanded, so that the mature size of the pinnae cannot be judged.

**5. *Lomagramma angustipinna* COPEL.** Univ. Cal. Publ. Bot. 18 (1942) 222; Philip. J. Sc. 78 (1950) 402, pl. 6A. — Type: BRASS 13446, Idenburg River, W. New Guinea, 750 m (GH; dupl. in MICH).

*Rhizome* 7 mm wide, containing 4 meristemes besides the root-bearing ventral one; rhizomescales 1–2 mm long, cell-walls very dark. *Sterile acrophylls*: stipe 14 cm; lamina 50 cm long with c. 30 pairs of pinnae, lower ones decreasing; middle pinnae  $10\frac{1}{2}$  by 0.8 cm, falcate-acuminate, subsessile, base very narrowly cuneate on basiscopic side, broader on acroscopic, edges entire, texture thin, veins fine, distinct on both surfaces. *Fertile pinnae* to 9 cm by 3 mm, on stalks to 2 mm long.

Distr. *Malesia*: W. New Guinea. Known only from type collection.

**6. *Lomagramma pteroides* J.SM.** in Hook. J. Bot. 3 (1841) 402; *ibid.* 4 (1841) 152; in Hook. Gen. Fil. (1842) t. 98; COPEL. Philip. J. Sc. 1 (1906) Suppl. 166; v.A.v.R. Handb. Suppl. (1917) 438; HOLTUM, Gard. Bull. S. S. 9 (1937) 213, pl. 13; COPEL. Fern Fl. Philip. (1960) 273. — *Acrostichum blumeianum*

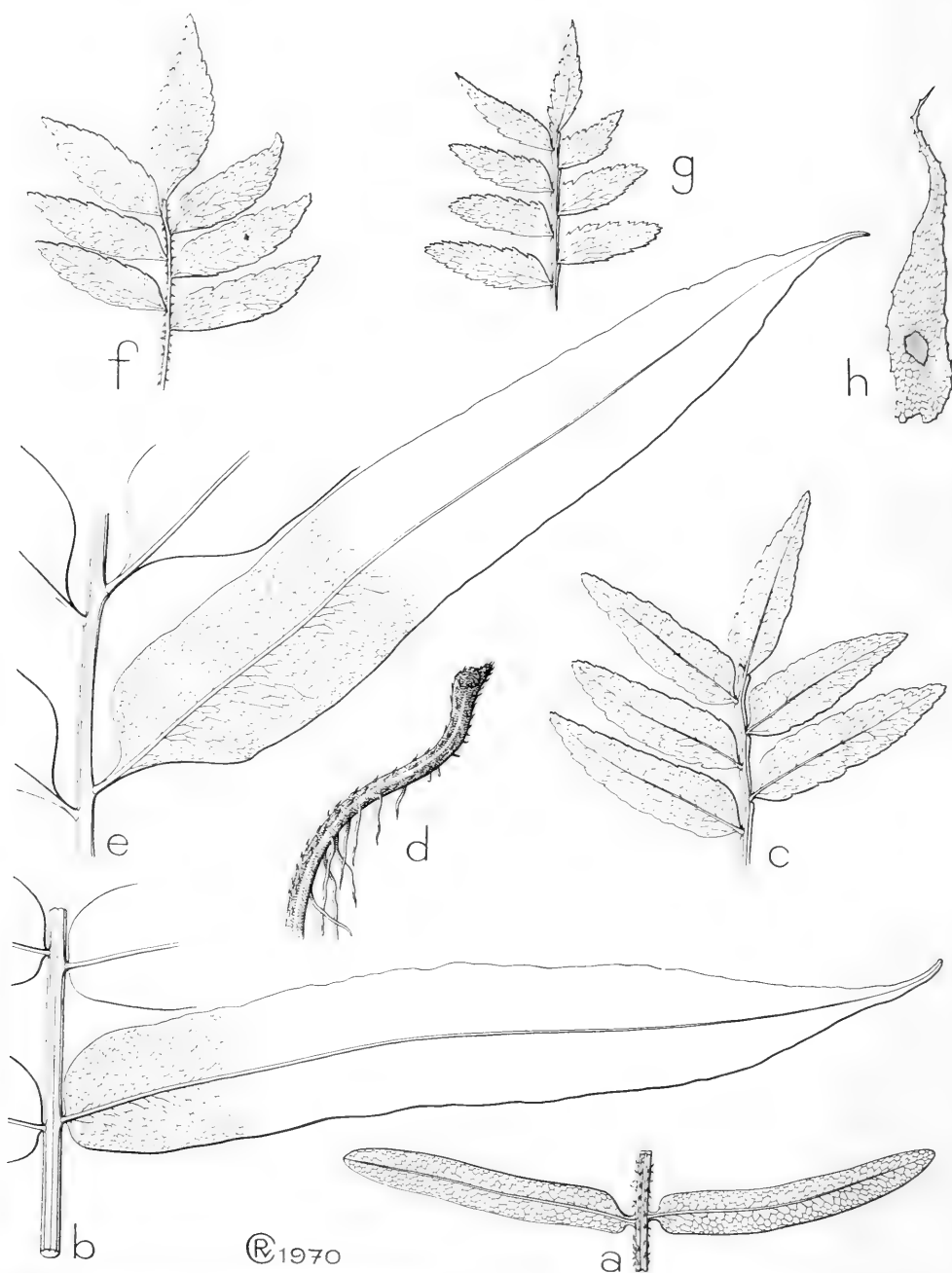


Fig. 10. *Lomagramma novoguineensis* (BRAUSE) C. CHR. *a.* Fertile pinnae,  $\times \frac{2}{3}$ . — *L. sinuata* C. CHR. *f. papuana* C. CHR. *b.* Sterile acrophyll, *c.* apex of bathyphyll, *d.* rhizome of young plant, all  $\times \frac{2}{3}$ . — *L. sinuata* C. CHR. Typical form, *e.* sterile acrophyll, *f.* apex of bathyphyll, both  $\times \frac{2}{3}$ . — *L. melanolepis* v.A.v.R. *g.* Apex of bathyphyll,  $\times \frac{2}{3}$ , *h.* scale from rhizome,  $\times 20$  (*a* DOCTERS VAN LEEUWEN 9616, *b-c* NGF 17699, *d, h* cult. Kew, origin Lae, *e* KOORDERS 23554, *f* BAKHUIZEN VAN DEN BRINK Jr 3664, *g* NGF 15892).

(FÉE) HOOK. Spec. Fil. 5 (1864) 268, p.p.; BAKER, Syn. Fil. (1869) 423, p.p. — *Polybotrya pteroides* (J.Sm.) KUHN, Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 295. — *Leptochilus lomarioides* BL. var. *pteroides* v.A.v.R. Handb. (1908) 746. — Type: CUMING 223, Luzon (BM; dupl. in K).

*L. pteroides* var. *subcoriacea* COPEL. Philip. J. Sc. 3 (1908) Bot. 32; v.A.v.R. Handb. Suppl. (1917) 439. — *L. subcoriacea* COPEL. Philip. J. Sc. 40 (1929) 308; Fern Fl. Philip. (1960) 274. — Type: COPELAND 1736, Mindanao (MICH; dupl. in B, BM, P).

*L. pedicellata* COPEL. Philip. J. Sc. 81 (1952) 23; Fern Fl. Philip. (1960) 275. — Type: EDANO PNH 531, Palawan (MICH).

*L. cordata* COPEL. Philip. J. Sc. 84 (1955) 162, t. 2. — Type: SULIT PNH 20277, Biliran (MICH). — Fig. 11a-d.

*Bathyphylls* with up to 28 pairs pinnae have lobed terminal lamina continuous with rachis; lower pinnae gradually reduced, lowest c. 7 by 3 mm, largest pinna  $2\frac{1}{2}$  by 0.7 cm, base unequally cuneate (more narrowly on basiscopic side), edges crenulate with teeth 2-3 mm apart, apex often not acute, bases and apices of lower pinnae more rounded; stipe, rachis and costae rather densely scaly, scales dark; pinnae reddish when dry; veins strongly raised on both surfaces. *Sterile acrophylls*: stipes 20-30 cm, pinnae commonly 1.2-1.8 cm wide, 12-15 cm long (largest seen 22 by 2.2 cm), base slightly unequally subtruncate to subcordate, edges subentire and parallel, apex acuminate and somewhat falcate, irregularly sinuate or somewhat toothed, uppermost pinnae gradually smaller with less truncate base and more toothed apex, lowest pinnae not much reduced but often with cordate

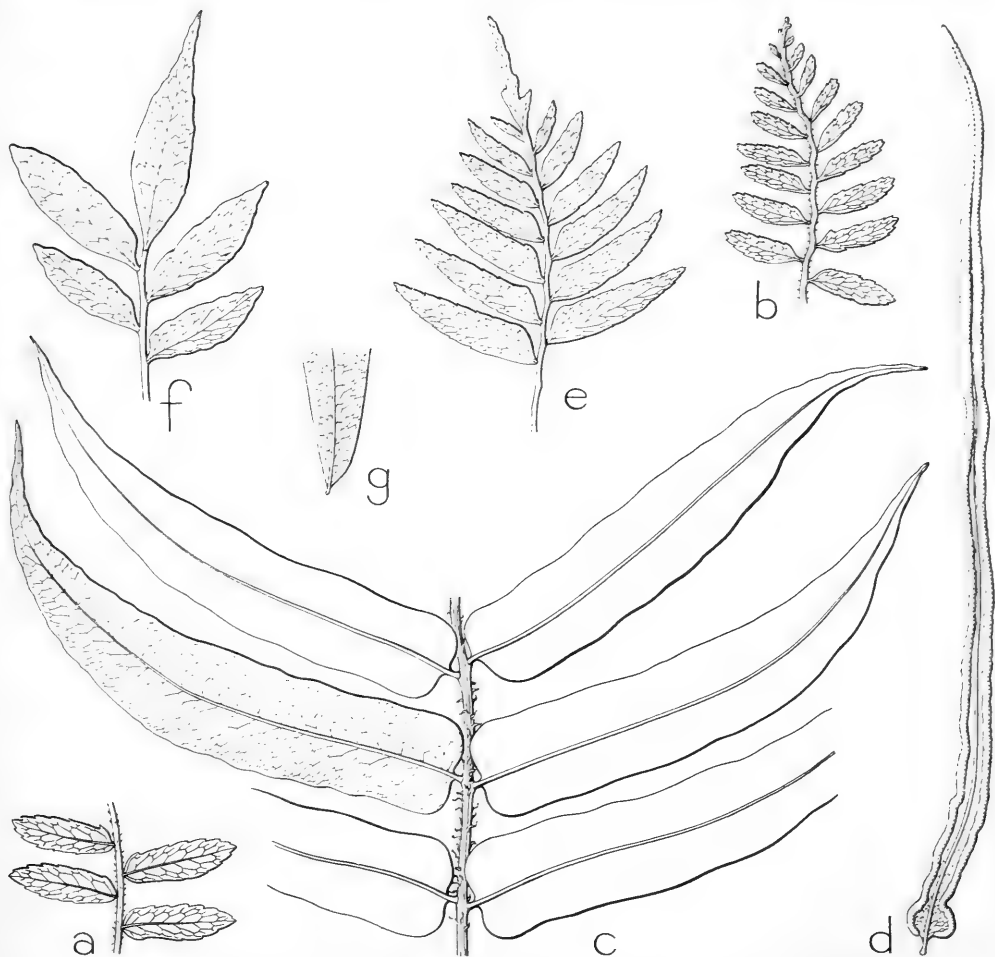


Fig. 11. *Lomagramma pteroides* J. Sm. a. Middle pinnae of bathyphyll, b. apex of bathyphyll, c. sterile acrophyll, d. fertile pinna, all  $\times \frac{2}{3}$ . — *L. sumatrana* v.A.v.R. e. Apex of bathyphyll,  $\times \frac{2}{3}$ . — *L. perakensis* BEDD. f. Apex of bathyphyll, g. base of pinna of acrophyll, both  $\times \frac{2}{3}$  (a-b EDANO 476, c-d ELMER 9068, e MATTHEW s.n., Jan. 1907, f-g HOLTUM 24994).





Fig. 12. *Lomagramma sinuata* C. CHR. Transition from bathyphylls (centre) to acrophylls (base, left & right), Cult. R.B.G. Kew, origin NE. New Guinea (Photogr. R. VAN CREVEL).



base; texture thin, colour often reddish when dry; veins slightly prominent, areoles rather small, dark scales rather abundant. *Fertile fronds*: pinnae commonly to 20 cm long, base unequally cuneate, widening suddenly from a winged stalk to 10 mm long; base of pinna 7–10 mm wide, only the edges fertile, upper part gradually narrowed, distal half sometimes covered with sporangia but often with a narrow sterile band each side of midrib.

*Distr. Malesia*: Philippines (Luzon, Palawan, Negros, Panay, Mindoro, Mindanao).

*Ecol.* Apparently in lowland forest and to c. 1000 m (records few).

*Notes.* I have not seen the type of *L. cordata* COPEL. The photographic illustration shows a complete frond sterile at the base, fertile in distal parts. The sterile pinnae are only 7 mm wide, but on such a frond would probably not be normal. The fertile pinnae are rather long-stalked even to the apex of the frond (stalks are evidently 4–6 mm long, not 4–6 cm as in the printed description) where stalks are usually shorter.

M. G. PRICE has collected on Mt Makiling bathyphylls of this species in which the lower pinnae are gradually decrescent, but the lowest are elongate and deeply lobed so as to be almost pinnate.

**7. *Lomagramma sumatrana*** V.A.V.R. Bull. Jard. Bot. Btzg III, 2 (1920) 158; HOLTUM, Gard. Bull. S. S. 9 (1937) 217, pl. 16; Rev. Fl. Mal. 2 (1954) 477, f. 280. — Type: LÖRZING 5564, Sumatra, Sibolangit (BO; dupl. in P, SING). — **Fig. 11e.**

*Bathyphylls*: stipes 3–10 cm long; lamina to 40 by 9 cm; pinnae 20–30 pairs, lowest rather reduced and deflexed, upper gradually smaller, uppermost grading into lobes of frond-apex which is not pinna-like not jointed; middle pinnae to 5 by 1.2 cm, at right angles to rachis, acroscopic base broadly subtruncate to subauriculate, basispic narrow, rounded, sides almost parallel for  $\frac{2}{3}$  of length, then tapering to acute apex; edges shallowly crenate with 1–2 teeth at distal end of each crenation; texture thin, veins slender, prominent. *Sterile acrophylls*: stipes to 20 cm, frond to at least 90 cm long; lowest pinnae somewhat reduced and more distant, uppermost gradually smaller; middle pinnae to 18 by  $2\frac{1}{2}$  cm, sessile or subsessile, acroscopic base broadly cuneate, basispic narrower and rounded to cuneate; edges usually with a few irregular teeth towards acuminate apex; texture thin, veins conspicuous. *Fertile pinnae* to 15 cm by 5 mm, on stalks to 2 mm, upper ones gradually reduced, uppermost c. 4 cm long.

*Distr. Malesia*: N. Sumatra, Malay Peninsula.

*Ecol.* Near rocky streams in forest, 0–500 m.

*Note.* Acrophyll pinnae of this species are very similar in shape to those of *L. sinuata*, though never so large; bathyphylls show a constant difference in all cases observed.

**8. *Lomagramma brooksii*** COPEL, Philip. J. Sc. 3 (1908) Bot. 345; *ibid.* 7 (1912) Bot. 60; V.A.V.R. Handb. Suppl. (1917) 439; HOLTUM, Gard. Bull. S. S. 9 (1937) 199, pl. 8 (by error as *L. borneensis*). — Type: HEWITT & BROOKS, Bongo Mt, Sarawak (MICH).

*Bathyphylls* on young plants, with apical lamina continuous with rachis, to 20 cm long with 12–15

pairs pinnae; larger bathyphylls with apical pinna articulate; pinnae of youngest plants with rounded apex, of larger ones acute; acroscopic base broadly subtruncate and sometimes slightly auricled, basispic much narrower, rounded; edges toothed only towards apices; texture thin, veins distinct and slightly raised on both surfaces. *Sterile acrophylls*: stipe short (often only 4 cm); fronds to 75 cm long; middle pinnae at right angles to rachis, sessile, to 15 by 2 cm, basispic base rounded to subcordate, a little narrower than subtruncate acroscopic base; edges entire, sometimes sinuate towards apices; texture thin but very firm, veins slightly raised; lower pinnae slightly stalked, their bases symmetrical and subcordate. *Fertile pinnae* to 15 cm by 4 mm, more commonly smaller, on winged stalks to 2 mm.

*Distr. Malesia*: N. Borneo (Sarawak), North & Central Celebes, Philippines (Luzon, Palawan).

*Ecol.* Near streams in forest, at 300–1500 m.

*Note.* The North Celebes specimen (POSTHUMUS 2335) has bathyphylls with 20 pairs of pinnae and still a narrow lobed apical lamina continuous with the rachis. Central Celebes specimens (SARASIN 953) have fronds not completely expanded.

**9. *Lomagramma leucolepis*** HOLTUM, Blumea 14 (1966) 224. — Type: BRASS 12950, W. New Guinea, Idenburg River (L; dupl. in BM, BO, GH, MICH).

*Rhizome* 12 mm Ø, containing 3 meristeles besides ventral root-bearing one; scales rather light brown, not clathrate, to  $1\frac{1}{2}$  mm wide. *Sterile acrophylls*: stipes 12 cm long, sparsely covered with small pale brown scales, only the smallest clathrate; frond 75 cm long, rachis bearing scales with bullate bases; pinnae to 14 by 2 cm, sessile, basispic base subcordate or rounded, acroscopic broader and rounded in lower pinnae, broadly cuneate in upper, apex acuminate, edges very broadly crenate in distal  $\frac{1}{3}$ ; veins fine, distinctly raised on both surfaces; scales rather abundant on midrib and veins of lower surface, bullate-acuminate. *Fertile pinnae* of type mostly broken, largest intact one (near base of frond) 7 cm long (in herb. MICH to  $10\frac{1}{2}$  cm), 3–5 mm wide, subsessile, base rounded, slightly narrowed towards blunt apex.

*Distr. Malesia*: W. New Guinea. Only known from the type.

*Ecol.* Steep slope in rain-forest, at 1200 m, locally common.

**10. *Lomagramma sinuata*** C.CHR. Svensk Bot. Tidskr. 16 (1922) 98, f. 5; HOLTUM, Gard. Bull. S. S. 9 (1937) 215; BACKER & POSTH. Varenfl. Java (1939) 153; COPEL, Philip. J. Sc. 78 (1949) 401; HOLTUM, Blumea 14 (1966) 222. — *L. sinuata* f. *papuana* C.CHR. Brittonia 2 (1937) 302. — Type: KAUDERN 73, N. Celebes (BM; dupl. in BO).

*Leptochilus cuneatus* R.BONAP. Notes Pterid. 14 (1923) 453. — Type: BROOKS 467, Bencoolen, Sumatra (P; dupl. in BM).

*Lomagramma* sp. HOLTUM, Gard. Bull. S. S. 9 (1937) 219. — **Fig. 10b–f, 12.**

*Rhizome* often bearing 3–5 fronds close together at wide intervals; scales on rhizome-apex distinctly clathrate with very dark cell-walls, edges paler and sometimes fringed. *Bathyphylls*: fronds with 10–12 pairs of pinnae have apical pinnae jointed to rachis; rachis distinctly winged; middle pinnae to 9 by



Fig. 13. *Lomagramma melanolepis* v.A.v.R. Young plant, bathyphylls stage. Cult. R.B.G. Kew, origin NE. New Guinea (Photogr. R. VAN CREVEL).

2 cm with broadly cuneate acroscopic base and narrowly cuneate or slightly rounded basicopic, edges shallowly crenately lobed (more deeply towards pinna-apex) with irregular small teeth on the crenations, apex rounded to bluntly pointed. *Sterile acrophylls* to 100 cm long with many pinnae; middle pinnae 11 by 2 cm to 20 by 4 cm, more or less stalked, acroscopic base broadly cuneate, its edge forming a distinct S-curve, basicopic base narrowly cuneate (sometimes rather rounded in New Guinea), edges almost entire on larger fronds, slightly and irregularly toothed towards apex on smaller ones, texture thin, veins fine and distinctly raised on both surfaces. *Fertile fronds*: pinnae 10–25 cm long, 5–8 mm wide, on stalks 2–8 mm long.

Distr. *Malesia*: S. Sumatra, Java, Lesser Sunda Is. (Bali), Borneo, Celebes, Moluccas (Batjan), New Guinea; Solomon Is.

Ecol. In forest near streams, up to 750 m.

Notes. The type, and some other specimens from Celebes and Java, have pinna-stalks 5 mm or more long, narrowly winged on the acroscopic side (fig. 10e). Most specimens from Java and New Guinea have pinnae almost sessile but do not differ significantly in other ways, though some in New Guinea (*f. papuana*, fig. 10b) are more rounded basiscopically.

In 1937 (*l.c.*, p. 219) I thought that most specimens now ascribed to this species from Java probably represented a distinct species, but the specimens in the Bogor herbarium on which I based this opinion did not include sterile acrophylls from fully mature plants nor fertile fronds. In the Rijksherbarium at Leiden are excellent specimens of large sterile acrophylls with quite entire pinnae 3 cm wide, and fertile fronds with pinnae 6–7 mm wide; these are indistinguishable from typical *L. sinuata* except that the sterile pinnae are shorter-stalked. Bathyphylls from West Java have more deeply crenate pinnae with a more acute apex than pinnae of fronds of a comparable size attributed to *L. sinuata* in East Java; this may be due to environmental factors. The species is probably now rare in Java owing to destruction of lowland forest.

**11. *Lomagramma copelandii* HOLTTUM**, Gard. Bull. S. S. 9 (1937) 201, pl. 9, 10; COPEL. Fern Fl. Philip. (1960) 274. — Type: RAMOS & EDANO BS 28826, Mt Binuang, Prov. Tayabas, Luzon (BO; original at MAN lost).

*L. pteroides* var. *negrosensis* COPEL. in Elmer, Leaf. Philip. Bot. 2 (1908) 393; v.A.v.R. Handb. Suppl. (1917) 438. — Type: ELMER 10175, Negros (MICH).

*Bathyphylls* to 15 cm long with apical lamina continuous with rachis, larger ones with jointed small terminal pinna; pinnae to c. 15 pairs, largest  $6\frac{1}{2}$  by 1.8 cm, acroscopic side broadly cuneate at base, basicopic rounded and narrower, edges crenately lobed (lobes c. 5 mm) each lobe with 2–4 short teeth, largest pinnae toothed only towards acute apex, on smaller fronds apex blunt. *Sterile acrophylls*: stipe 15–25 cm; pinnae to 18 by 3 cm, sessile, acroscopic base of middle pinnae broadly cuneate to subtruncate, basicopic rounded, edges slightly undulate, not toothed, apex acuminate, texture thin, veins conspicuous. *Fertile fronds*: pinnae to 20 cm long and 4 mm wide, sessile, base

not dilated, whole lower surface except costa soriferous, areoles long and narrow.

Distr. *Malesia*: Philippines (Luzon, Catanduanes, Samar, Bohol, Negros, Mindanao).

Ecol. Apparently in lowland forest, altitudes not recorded.

Note. ELMER distributed, with at least some specimens of his collection no 16919, fertile pinnae of *Lomariopsis subtrifoliata* with sterile fronds of *Lomagramma copelandii*.

**12. *Lomagramma melanolepis* v.A.v.R.** Bull. Jard. Bot. Botz III, 5 (1922) 212; HOLTTUM, Gard. Bull. S. S. 9 (1937) 208. — Type: BEGUIN 1114, Ternate (BO). — Fig. 10g–h, 13, 14.

*Rhizome-scales* 4–5 mm long, narrow, dark-clathrate with paler edges bearing some hairs; fronds often 3 close together. *Bathyphylls* (New Guinea) with closely-placed strongly toothed pinnae which are commonly c. 20 by 6 mm; apical pinna jointed to rachis on fronds with 12 pairs of pinnae. *Sterile acrophylls*: middle pinnae subsessile, to 12 by 2 cm, rather thin with distinctly raised veins, base rather broadly cuneate on acroscopic side, narrower and cuneate to narrowly rounded on basicopic, edges entire or somewhat toothed towards apex. *Fertile fronds*: pinnae to 9 cm long and 2–3 mm wide, usually stalked.

Distr. *Malesia*: Moluccas (Ternate, Halmaheira), New Guinea, d'Entrecasteaux Is.

Ecol. In lowland forest, to 900 m.

Note. This is very like *L. sinuata*, but has consistently smaller pinnae of both bathyphylls and acrophylls and narrower fertile pinnae. I have included numerous New Guinea collections which differ from the type in the very narrowly cuneate basicopic base of sterile pinnae. If further collections from the Moluccas should indicate that the New Guinea plants are distinct, the latter will need a new name.

**13. *Lomagramma brassii* HOLTTUM**, Blumea 14 (1966) 224. — Type: BRASS 24947, Goodenough I. (A).

*Rhizome* of adult plant 3–4 mm Ø, carrying fronds in two longitudinal rows; scales to 3 by  $\frac{1}{2}$  mm, clathrate with brown cell-walls. *Sterile fronds*: stipe 3–6 cm long; lamina to 25 cm long with 12–15 pairs of pinnae, apical one largest and jointed to rachis; a few basal pinnae gradually smaller and with rounded apices; middle pinnae of type to  $4\frac{1}{2}$  by 0.9 cm, of another collection 8 by 1.1 cm, sessile, basicopic base narrowly cuneate, acroscopic broadly so, apex tapered and acute, edges with an acute falcate tooth corresponding to each costal areole and irregular smaller intermediate teeth; veins forming one series of costal areoles and in the largest pinnae an irregular second series; small dark bullate-acuminate strongly clathrate scales abundant on lower surface of costa and a few on veins. *Fertile fronds*: lamina c. 15 cm long; pinnae 2 mm wide, largest  $2\frac{1}{2}$ – $5\frac{1}{2}$  cm long, apex rounded, stalks 1 mm long.

Distr. *Malesia*: New Guinea (Goodenough I.). Two collections.

Ecol. In transitional oak-rain-forest, 900 m, climbing to 2–3 m.

Note. This is very near *L. melanolepis*, but smaller, and the only clear difference is in the



Fig. 14. *Lomagramma melanolepis* v.A.v.R. Part of plant shown in fig. 13; bathyphyll with winged rachis and toothed pinnules which are all articulate (Photogr. R. VAN CREVEL).

slender rhizome of the adult stage of the plant. In view of the clear difference between *L. sinuata* and *L. melanolepis*, which is mainly one of size (and which is maintained by plants growing side by side in cultivation at Kew) I think it probable that *L. brassii* is a distinct species.

A plant in cultivation at Kew (accession n. 020/74-00297, J. R. WOODHAMS), collected in the vicinity of Sogere in Papua climbing on the trunk of a dead *Cyathea*, agrees well with the above description except that the pinnae are smaller: sterile to  $3\frac{1}{2}$  by 1.1 cm, fertile c.  $1\frac{1}{2}$  by 0.3 cm. The small size may be due to conditions of cultivation; at least the plant confirms that the fertile condition can be attained by quite small plants, a condition otherwise unknown in the genus.

#### Doubtful species

*Lomagramma guianensis* (AUBL.) CHING, Amer. Fern J. 22 (1932) 17. — *Polypodium guianense* AUBL. Hist. Pl. Guian. 2 (1775) 962.

This species occurs in the Greater Antilles and in South America from Guiana to southern Brazil. In habit, frond-form, venation and articulated pinnae it agrees closely with species of *Lomagramma* in Malesia and the Pacific. It differs in the following characters: acrophyll frond-apex deltoid, lobed, not pinna-like (as in bathyphylls of Malesian species); small scales not bullate; paraphyses hair-like with a glandular apical cell; spores with folded perispore as in *Bolbitis* and *Lomariopsis*. The paraphyses are much like the hairs on the margins of small scales of *Lomariopsis*, but scales on rhizome and frond are clathrate as in *Bolbitis* and *Lomagramma*. CHING included this species in *Lomagramma*, but its differences from Malesian

species are such that I doubt its genetic unity with them; an independent origin in South America seems to me more probable, in which case a new genus might be established for it.

*Lomagramma sorbifolia* (WILLD.) CHING, Lingn. Sc. J. 12 (1933) 566; HOLTUM, Gard. Bull. S. S. 9 (1937) 220. — *Aspidium sorbifolium* WILLD. Spec. Pl. 5 (1810) 23. — *Nephrodium sorbifolium* (WILLD.) PRESL, Rel. Haenk. (1825) 31, *nomen tantum*; HOLTUM, Novit. Inst. Bot. Univ. Carol. Prag. 1968 (1969) 17.

WILLDENOW's type is a detached bathyphyll; the only locality given is "Ind. or." When CHING regarded WILLDENOW's specimen as conspecific with *L. lomarioides* (BL.) J.SM. he took a very broad view of the latter species; certainly WILLDENOW's specimen is quite unlike bathyphylls of *L. lomarioides* as described in the present work. It seems to me probable that WILLDENOW's specimen represents the same species as the type of *L. matthewii* (CHING) HOLTUM, known from Assam, Tonkin and Thailand, but this cannot be regarded as certain, and I prefer to regard WILLDENOW's name as of doubtful application.

PRESL gave the name *Nephrodium sorbifolium* to two bathyphylls, representing two distinct species, collected by HAENKE in Luzon; I identify the specimens as *L. copelandii* and *L. pteroides*.

#### Excluded

*Lomagramma praestantissimum* (BORY) GRIES. Fl. Brit. W. Ind. (1864) 678 = *Neurocallis praestantissimum* (BORY) FÉE.

*Lomagramma wilkesiana* (BRACK.) COPEL. Philip. J. Sc. 3 (1908) Bot. 32 = *Teratophyllum wilkesianum* (BRACK.) HOLTUM.

### 5. ELAPHOGLOSSUM

J.SM. in Hook. J. Bot. 4 (1841) 148, *nom. cons.*; in Hook. Gen. Fil. (1842) t. 105A; MOORE, Ind. Fil. (1857) xvi; *ibid.* (1862) 351; J.SM. Hist. Fil. (1875) 125; BEDD. Handb. Ferns Br. India (1883) 416; CHRIST, Farnkr. Erde (1897) 33; Neue Denkschr. Allg. Schweiz. Ges. Naturw. 36 (1899) 1–159; DIELS in E. & P. Nat. Pfl. Fam. 1, 4 (1899) 331; C.CHR. Ind. Fil. (1905) lii, 302; COPEL. Gen. Fil. (1947) 119; MORTON, Amer. Fern J. 45 (1955) 11; W. R. ANDERSON, Regn. Veget. 40 (1965) 18; HOLTUM, Blumea 14 (1966) 317–326. — *Olfersia* PRESL, Tent. Pterid. (1836) 232, *p.p. max.*, *non* RADDI. — *Aconiopteris* PRESL, Tent. Pterid. (1836) 236. — *Acrostichum* (*non* L.) FÉE, Hist. Acrost. (1845) 8, 27. — *Dictyoglossum* J.SM. Bot. Mag. 72 (1846) Comp. 18. — *Acrostichum sect. Elaphoglossum* HOOK. Spec. Fil. 5 (1864) 195–241; HOOK. & BAKER, Syn. Fil. (1868) 400. — **Fig. 15–24.**

*Rhizome* creeping, in Malesian *spp.* usually dorsiventral and bearing 2-ranked fronds with a branch-bud at the base of each (some tropical American *spp.* with fronds in more than 2 ranks and a few with radially organized rhizome); young parts protected by *scales* which are usually cordate (often strongly) at the base, with edges bearing short teeth by projection of the wall between 2 adjacent cells, or hairs which may be of one or several cells, some cells usually glandular; outgrowth from the rhizome (in all Malesian *spp.*) forming similarly scaly terete *phyllopodia* to



which fronds are  $\pm$  distinctly jointed (when dry, phyllopodia are usually darker than stipes). *Fronds* simple, entire, dimorphous, stipitate or sessile, usually  $\pm$  coriaceous, often with a colourless cartilaginous thinner edge, costa usually somewhat prominent and grooved on upper surface, rounded and  $\pm$  prominent on lower; veins conspicuous or not, forked once or twice, all branches almost reaching the margin, their tips in most *spp.* free and thickened, in a few *spp.* the vein-tips joining each other in a series of arcs just within the margin; small scales  $\pm$  abundant, persistent or not, on both surfaces, in a few species peltate. *Fertile fronds* with smaller lamina than sterile, sometimes of different and distinctive shape, often with longer stipes than sterile, the lower surface quite covered with sporangia except for the thin decoloured margin and (in some species) a narrow decurrent part of the base. *Spores* with well-developed folded perispore.

Type species: *Acrostichum conforme* Sw.

**Distribution.** More than 400 *spp.*, throughout wetter parts of tropics and subtropics, with greatest diversity on the Andes.

**Ecology.** Almost all Malesian species are epiphytes, though some will grow on mossy rocks in low forest at high altitudes; one is reported growing on wet rocks in a stream-bed (*E. resiniferum*); few if any grow in full exposure to the sun. They usually grow in association with other ferns and orchids on heavily-laden tree-branches; when seen at a distance their simple entire fronds often resemble orchid leaves and so may be overlooked. Few species occur in lowland forest, most at 1000–2500 m. The fronds of most are somewhat fleshy, with thick cuticle, and some are very rigid when dried; those with thinnest fronds occur in sheltered places, some on tree-trunks not far above ground level (*E. melanostictum*). The surface often shows a bluish hue. Fronds are shed when old by breaking at the joint between phyllopodium and stipe, where there is an internal change of structure though no true absciss-layer (see BELL, *infra*, 1951) and I believe that most fronds probably persist for more than a year, some possibly 2 years or more (old ones may bear a considerable growth of epiphyllous bryophytes). Fertile fronds are produced periodically, probably in response to dry weather, as in other genera of this group. I had a plant of *E. amblyphyllum* in cultivation in a hanging pot in Singapore for more than 20 years and only once saw a fertile frond on it, perhaps because it was always watered on rainless days (the species was native locally on old trees in mangrove but such trees are fast disappearing. R. M. LLOYD has discussed some aspects of the ecology of tropical American species (Amer. Fern J. 60, 1970, 73–82); at high altitudes only about 50% are epiphytic. Some species lack a joint at the base of a stipe; these were mostly epiphytic, not terrestrial.

**Vegetative morphology and anatomy.** P. R. BELL has published "Studies in the genus *Elaphoglossum*" in five papers, based largely on his own observations of tropical American species (Ann. Bot. n.s. 14, 1950, 545–555; *ibid.* 15, 1951, 333–346, 347–357; *ibid.* 19, 1955, 173–199; *ibid.* 20, 1956, 69–88). He dealt with stelar structure in relation to habit, vascular supply to roots and branches in relation to bases of fronds, the anatomy of fronds and structure of scales and hairs. He proceeded to arrange in series observations on 87 *spp.* relating to (a) stelar structure (dorsiventral with fronds in 2 or more ranks, or radially symmetrical), (b) development of the joint, and aerenchyma of the phyllopodium, (c) scales on the frond; and works out the frequencies of various combinations of characters, thereby indicating that the species of Malaya (which alone of Malesian *spp.* he compared with American *spp.*) show predominant a condition he regards as primitive, having a combination of dorsiventral rhizome with 2 ranks of fronds, phyllopodium with joint at its tip and aerenchyma near its base, and flat scales with basal attachment. So far as I have been able to observe, the other Malesian species agree in the 2-ranked arrangement of the fronds, which resemble that of young plants in the other genera of the group. I have not examined the aerenchyma of phyllopodia; the external characters associated with this are difficult to see clearly on dried specimens (and to examine them one needs to remove all scales) and should be studied by someone having access to abundant living plants.

Scales are important diagnostically, both on rhizome and surface of fronds; size, shape and colour are distinctive, also the nature of marginal hairs and the position of glandular cells. It appears that glandular cells of many species can produce a resinous exudation which may persist after the scale has fallen or become disintegrated. This also needs examination on living plants. A further comment on scales is given in the section on Taxonomy below.

**Venation** is often not easy to distinguish, especially the form of the ends of the veins which can usually only be seen if the frond is cleared with chloral hydrate. In a few species the ends of the veins anastomose just within the margin but these do not constitute a natural group and PRESL's genus *Aconiopteris*, based on this character, cannot be maintained; probably not all cases of this kind have yet been recognized, because of opacity of fronds.

**Gametophyte.** A. G. STOKEY and L. R. ATKINSON have published a study of gametophytes of 19 tropical American *spp.* (Phytomorphology 7, 1957, 275–292); these include one (*E. gayanum* (FÉE) MOORE) belonging to the group of *E. conforme*, which shows no peculiar characters (see *infra* on subdivision of

genus). Prothalli are slow-growing and long-lived, ribbon-like with crisped wings, marginal rhizoids and abundant short hairs with waxy caps; these wax-bearing hairs may be compared with glandular hairs on scales of the sporophytes. Marginal rhizoids are reported by STOKEY and ATKINSON as occurring also in *Selliguea* BORY and in Grammitoid ferns; their presence is perhaps an adaptation to epiphytic growth among mosses, and cannot be an indication of any close relationship between such very diverse genera as *Elaphoglossum*, *Selliguea* and *Grammitis*. Archegonia and antheridia "conform in type to those of the higher ferns". Gametophytes of *Elaphoglossum* are thus distinct from those of all other genera in the present group. It may be relevant that NAYAR found narrow ribbon-like gametophytes in *Microsorium pteropus* (BL.) CHING (*Polypodiaceae*) whereas the type species *M. punctatum* (L.) COPEL. has normal cordate ones. NAYAR separated *M. pteropus* as type of a distinct genus *Kaulinia*, but there is no reason to think that the two genera are not closely related (Taxon 13, 1964, 67-69).

**Taxonomy.** The generic name *Elaphoglossum* was proposed by SCHOTT in 1834 for certain specified species of the composite genus *Acrostichum*, but he gave no description, and therefore his name, though long accepted, does not comply with the present conditions of valid publication (MORTON, l.c. 1955). When PRESL attempted a more complete survey of the Acrostichoid ferns (1836) he adopted the name *Olfersia* RADDI for the species listed as *Elaphoglossum* by SCHOTT; but RADDI's name was given originally to the single species *O. corcovadensis*, which is now included in the earlier *Polybotrya* H. & B. PRESL also established a new genus *Aconiopteris* for *Acrostichum subdiaphanum* HOOK. & GREV., the only distinctive character of which is that the veins join in a series of arcs along the margin. This character is not now regarded as significant for generic separation, and the type species of *Aconiopteris* is now included in the same genus as most of those listed as *Olfersia* by PRESL. Thus, according to a strict interpretation of the Code, *Aconiopteris* is the correct name for the species which have been commonly called *Elaphoglossum* for more than a century. The first valid publication of the name *Elaphoglossum* was by JOHN SMITH in 1841. A proposal was therefore made (ANDERSON 1965) for the conservation of *Elaphoglossum* J.Sm. as against *Aconiopteris* and this has been approved.

In 1845 FÉE published his elaborate and finely illustrated work on the Acrostichoid ferns, in which he criticized PRESL's arrangement. He restricted the genus *Olfersia* PRESL to two species and redefined *Acrostichum* to include the bulk of PRESL's *Olfersia*; for *Acrostichum* as restricted by PRESL (but excluding a few species) he proposed the new name *Chrysodium*. He maintained *Aconiopteris* as a separate genus. In 1846 JOHN SMITH published the name *Dictyoglossum* for tropical American species having anastomosing veins, but a generic separation on this character is now regarded as unnatural. In 1857 MOORE adopted the name *Elaphoglossum* in the modern sense and transferred many names to it, but HOOKER (1864) reverted to a comprehensive *Acrostichum* with *Elaphoglossum* as a section. BEDDOME (1865 onwards) followed MOORE, and the name *Elaphoglossum* came into quite general use after the publications of CHRIST (1897, 1899) and DIELS (1899).

Subsequent treatment of the genus in relation to other genera in systems of classification is dealt with in the introduction to the present group of genera (*supra* p. 257). One aberrant suggestion should however be mentioned. In his Monograph (1899, p. 17) CHRIST recognized the isolation of *Elaphoglossum* among Acrostichoid ferns, but pointed out similarities between the genera *Elaphoglossum* and *Syngamma*, noting however the great difference between the bristle-like hairs which clothe the rhizome of *Syngamma* and the scales of *Elaphoglossum*. BOWER accepted a relationship between the two genera, and placed them as simple-fronded derivatives of the same stock as *Metaxya* (The Ferns 1, 1928, 233-238). But the superficial resemblance between *Elaphoglossum* and *Syngamma* is due to the kind of convergent evolution that has occurred many times among ferns. It is clear that one general evolutionary trend which has occurred along several separate lines is reduction from a branched frond to a simple one; *Syngamma* and *Elaphoglossum* appear to be the ends of two quite different such lines. They differ greatly in spores as well as in scales; probably a study of sporangia would show further differences. The association of *Syngamma* (an exclusively Old World genus) and *Elaphoglossum* with *Metaxya*, which is an isolated monotypic south American genus placed with some doubt in a separate subfamily of *Cyatheaceae* (Fl. Males. II, 1, 1963, 72) seems to me highly improbable. I know of no other author who has seriously upheld BOWER's ideas on these genera.

Subdivision of the genus. PRESL (1836: 233-235) divided the species of his genus *Olfersia* into two 'phalanges': *frons herbacea* and *frons coriacea*. This is not a practicable arrangement. FÉE (1845) divided the species of his *Acrostichum* into two groups, *Oligolepideae* and *Polylepideae*. Though this also is not satisfactory, it seems to me to be in the right direction, namely to use the scales on the fronds as a basis for subdivision. The type species of the genus, *E. conforme*, comes into FÉE's *Oligolepideae*. If now we use characters of the scales, and not their abundance, to distinguish *E. conforme* and its allies from the species of FÉE's *Polylepideae*, we can have a clear-cut division; as almost all species of a re-defined *Polylepideae* have in fact conspicuously scaly fronds, the name is not inappropriate. It appears to me that this second division may be again subdivided on scale characters, as indicated below.

CHRIST (1899) divided the genus into two 'ordines', *Stenoneura* and *Condyloneura*, each ordo being divided into sections and subsections. The species of *Stenoneura* were said to have veins running to the margin without thickened tips, whereas in *Condyloneura* the veins are described as having thickened tips. In fact most species placed by CHRIST in *Stenoneura* are seen to have thickened vein-tips if the fronds are cleared with chloral hydrate, so that his main division is unreal; the minor subdivisions also are not more useful.

The following conspectus is tentative, for which reason I have not formally proposed any new names for subdivisions of the genus. The conspectus differs from that published by me in 1966 (*Blumea* 14: 319) owing to comments received from W. R. ANDERSON, University of Michigan, to whom I express my

thanks; he has made a far more thorough study of tropical American species than I could attempt. No doubt the present conspectus is over-simplified, and is not adequate to cover all tropical American species; it is intended only as a step towards more light on a complex problem.

1. Scales on frond bearing some marginal cells which are swollen and glandular, usually also bearing marginal hairs which consist of several cells, the terminal cell being glandular  
group of *E. conforme* (Sw.) J.Sm.
1. Scales on frond not bearing swollen glandular marginal cells except sometimes near the base; marginal hairs, if present, each consisting of a single cell which is usually acicular and thin-walled.
2. Scales on frond flat, with marginal hairs . . . . . group of *E. muscosum* (Sw.) MOORE
2. Scales on frond narrow, with reflexed edges (at least in basal part), thus bristle-like, lacking marginal hairs . . . . . group of *E. spathulatum* (BORY) MOORE

Malesian species. The earliest attempt at a comparative account of Malesian species was by BLUME, who published full descriptions and excellent plates of those he knew in Java (Fl. Jav. Fil. 1829). But BLUME adopted some earlier names, originally given to plants from other parts of the world which are distinct from the Java species (e.g. *Acrostichum decurrens*, *A. gorgoneum*, *A. viscosum*). Some other early names, notably *E. conforme* (described originally from St Helena) have also been used in too broad a sense. The result has been considerable confusion in the use of such names by past authors, and without reference to specimens one cannot always be sure of the sense in which such names have been used.

A few Malesian species are common in mountain forests, and have been frequently collected, especially *E. callifolium*, *E. angulatum* and *E. blumeum*. Most other species have been collected too little for a really good assessment of their full range of variation, and of their geographical distribution. This is especially the case in New Guinea, where (in Malesia) the genus has its greatest diversity, and several species are known only from single collections, so that their descriptions may need subsequent modification. Further collections of good sterile specimens would help considerably. It appears that the most widely distributed Malesian species are *E. angulatum* (mountains of E. tropical Africa, Mascarene Is., Ceylon and S. India, throughout Malesia) and *E. callifolium* (throughout Malesia and eastwards to Fiji).

Almost all Malesian species belong to the group of *E. conforme* in the conspectus. A few belong to the group of *E. muscosum*, none to that of *E. spathulatum*, the nearest members of which are in Polynesia (*E. samoense* BRACK., *E. rapaense* COPEL., *E. societatum* COPEL.) and in Africa (about 6 spp.), a curious distribution.

Key to Malesian species. Apart from separation of the few representatives of the group of *E. muscosum* (nos 45-48) the key which follows is not an attempt at a natural arrangement, but only an attempt to provide a means of identification, and is usable only for mature plants. Young plants often have fronds different in shape from older ones; in general, fronds on young plants have a lamina more gradually decurrent at the base and a broader apex than those on mature plants, and plants of immature size rarely have fertile fronds. The key should serve to identify most mature plants, whether or not they have fertile fronds. Fertile fronds are almost always narrower than sterile; in each species widths of the two are in a fairly constant ratio. A distinctive feature of fertile fronds in some species is that their stipes are much longer than those of sterile fronds, but this is not always a constant character. However, I believe that in general there is a good contrast between species in which the stipes of the two kinds of fronds are of similar length, and those in which the fertile stipes are twice (or more times) as long as the sterile ones.

Shape of fronds is always important, particularly the shape of the apex; there seems to be more variation in the base in some species. Size is also significant, but one must remember that plants of the same species in situations differing in altitude or in exposure may differ considerably in size, also in texture. Texture, and the degree of distinctness of veins, can be significant, especially extreme conditions, but many species are in an intermediate state between very thick and rather thin. The development of the colourless margin is certainly significant, though I think that a narrow margin of thick-walled colourless cells is always present. An anatomical study to show the relationship between internal structure and external form would be of interest, but is beyond the scope of the present work (an indication of the kind of anatomical structure which can occur at the margin of a frond is given by BELL, Kew Bull. 14, 1960, 81).

KEY TO THE SPECIES

1. Small scales on frond stellate or elongate, their marginal hairs glandular or with a glandular apical cell, thick-walled unicellular marginal hairs lacking; rhizome-scales various.
2. Lamina of sterile fronds rarely over 7 cm long; rhizome 1-2 mm Ø, fronds usually well-spaced on it.
3. Rhizome-scales light brown.
4. Sterile lamina elliptic, commonly 4-7 cm long, base decurrent as a narrow wing.
5. Fertile lamina spatulate, abruptly contracted at base and then decurrent as a narrow wing 2 cm long; rhizome-scales to 1 mm wide . . . . . 1. *E. bolanicum*
5. Fertile lamina narrowly elliptic, little decurrent; rhizome-scales 2 mm wide . . . . . 2. *E. habbemense*
4. Sterile lamina ovate, almost same shape and size as fertile, c. 2 cm long . . . . . 3. *E. pumilum*
3. Rhizome-scales dark . . . . . 4. *E. hellwigianum*
2. Lamina of sterile fronds usually more than 7 cm long; rhizome thicker.
6. Rhizome long-creeping with well-spaced fronds.
7. Apex of sterile fronds acute or short-acuminate.
8. Scales dark, glossy, 1 mm wide . . . . . 5. *E. brunneum*
8. Scales thin, medium brown, 2-3 mm wide . . . . . 6. *E. angulatum*



7. Apex of sterile frond rounded.
9. Rhizome-scales light brown; scales on frond red-brown . . . . . 7. *E. pullenii*
9. Rhizome-scales dark brown; scales on frond dark, glossy (not known in *no* 9).
10. Rhizome-scales to 5 by  $1\frac{1}{2}$  mm; stipe of sterile fronds 4–15 cm long . . . 8. *E. sclerophyllum*
10. Rhizome-scales shorter, less than 1 mm wide; stipe of sterile fronds 3–5 cm . . . 9. *E. repens*
6. Rhizome short, with closely-placed fronds.
11. Lamina of sterile frond decurrent to joint with phyllopodium or within 2 cm of joint.
12. Edge of sterile lamina conspicuously pale and thin,  $\frac{1}{2}$  mm or more wide.
13. Sterile lamina twice as wide as fertile.
14. Apex of sterile frond bluntly pointed or rounded, base cuneate and then decurrent for 4–7 cm as a wing 1–2 mm wide on each side of costa . . . . . 10. *E. ophioglossoides*
14. Apex of sterile frond short-acuminate, base narrowed evenly almost to joint with phyllopodium . . . . . 11. *E. latemarginatum*
13. Sterile lamina little wider than fertile . . . . . 12. *E. pellucido-marginatum*
12. Edge of sterile lamina not conspicuously pale and thin.
15. Sterile frond acuminate or apiculate.
16. Rhizome-scales 10–15 by 3–4 mm, light brown, thin; lamina widest above middle . . . . . 13. *E. thamnopteris*
16. Rhizome-scales much smaller, dark; lamina widest at middle.
17. Sterile frond *c.* 22 by 2 cm . . . . . 14. *E. idenburgensis*
17. Sterile frond much larger, to  $4\frac{1}{2}$  cm wide.
18. Apex of sterile frond acuminate.
19. Sterile frond 35–50 by  $3\frac{1}{2}$ –5 cm . . . . . 15. *E. archboldii*
19. Sterile frond to 35 by 2.3 cm . . . . . 27. *E. angustifrons*
18. Apex of sterile frond broad with a narrow apiculus 5 mm long . . . . . 16. *E. apiculatum*
15. Sterile frond not acuminate nor apiculate.
20. Sterile frond widest  $\frac{1}{3}$  from apex, narrowed rather abruptly to broad-pointed apex.
21. Rhizome-scales 15–20 mm long, 2 mm wide; fronds thick, veins obscure; costa broad and little prominent on lower surface. . . . . 17. *E. annamense*
21. Rhizome-scales not over 10 mm long; fronds rather thin, veins distinct; costa slender and prominent on lower surface.
22. Scales on surface of frond pale, bearing slender hairs 1 mm long; stipe of fertile frond 10–15 cm . . . . . 18. *E. melanostictum*
22. Scales on frond dark, bearing very short hairs; stipe of fertile frond 25–30 cm . . . . . 19. *E. heterostipes*
20. Sterile frond widest about middle, or if above middle narrowed gradually to a rounded apex.
23. Sterile frond widest at middle, apex acute; fertile frond to 2 cm wide . . . . . 20. *E. calanasanicum*
23. Sterile frond widest a little above middle, gradually narrowed to rounded apex; fertile fronds not over 1.3 cm wide . . . . . 21. *E. norrisii*
11. Lamina of sterile frond not thus decurrent.
24. Scales on rhizome dark, rigid, glossy.
25. Small scales on upper surface of frond dark, glossy, elongate, with dark rigid cylindrical marginal hairs each consisting of one cell with a small thin-walled cell at its apex.
26. Scales on lamina 1–2 mm long; fronds with broadly rounded apex . . . . . 22. *E. apoense*
26. Scales on lamina much smaller; apex of fronds not broadly rounded . . . . . 23. *E. vepriferum*
25. Small scales on upper surface otherwise, at least some of their marginal hairs multicellular with glandular apical cell.
27. Apex of sterile frond rounded.
28. Phyllopodia  $\frac{1}{2}$ –1 cm long; lamina of sterile frond always *c.* 10 times as long as wide.
29. Scales on costa and stipe appressed, on lamina very small . . . . . 24. *E. nigripes*
29. Scales on stipe and costa spreading, on lamina 1–2 mm long, abundant . . . . . 25. *E. melanochlamys*
28. Phyllopodia  $\frac{1}{2}$ –2 cm long; lamina of sterile frond often proportionately broader . . . . . 8. *E. sclerophyllum*
27. Apex of sterile fronds acute or acuminate.
30. Lamina of sterile frond *c.* 10 times as long as wide.
31. Rhizome-scales less than 1 mm wide, somewhat crisped; stipe of fertile frond not or little longer than that of sterile . . . . . 26. *E. nesioticum*
31. Rhizome-scales more than 1 mm wide, flat; stipe of fertile frond usually twice as long as sterile.
32. Sterile frond  $3\frac{1}{2}$ –5 cm wide, 35–50 cm long . . . . . 15. *E. archboldii*
32. Sterile frond to 2.3 cm wide, 35 cm long . . . . . 27. *E. angustifrons*
30. Lamina of sterile frond *c.* 5 times as long as wide.
33. Rhizome bearing fronds 5–10 mm apart; scales 6 by 1 mm; sterile lamina widest below middle, rather abruptly contracted at base, apex short-pointed . . . . . 5. *E. brunneum*
33. Rhizome bearing fronds close together; scales 10 by  $1\frac{1}{2}$  mm; sterile lamina widest at middle, base rather narrowly cuneate, apex acuminate . . . . . 28. *E. pallescens*
24. Scales on rhizome medium to light brown, mostly rather thin.

34. Lower surface of sterile lamina covered with a felt of narrow scales 2–3 mm long  
29. *E. arachnoideum*
34. Lower surface of lamina bearing smaller, usually appressed, scales.
35. Fronds of adult plants widest above middle, with rounded apices and decurrent bases.
36. Fronds lacking a fringe of spreading scales.
37. Rhizome-scales less than 1 mm wide . . . . . 30. *E. stenolepis*
37. Rhizome-scales 2 mm or more wide . . . . . 31. *E. amblyphyllum*
36. Fronds bearing a fringe of spreading scales . . . . . 32. *E. luzonicum*
35. Fronds of adult plants, if widest above middle, rather much narrowed upwards, apex not broadly rounded.
38. Sterile fronds with distinct thin pale edge which bears abundant scales 1–1½ mm long, persistent on young plants, mostly lost on old ones . . . . . 32. *E. luzonicum*
38. Sterile fronds without a fringe of scales.
39. Sterile lamina twice as long as wide (to 12 by 6 cm); stipe of fertile frond as long as sterile frond with its stipe . . . . . 33. *E. brevifolium*
39. Not this combination of characters.
40. Apex of sterile frond distinctly pointed, point broad or acute.
41. Sterile frond widest in distal half, base very gradually and evenly narrowed, stipe to 5 cm long . . . . . 19. *E. heterostipes*
41. Sterile frond widest at or below middle, base otherwise, stipe in most cases longer.
42. Pale margin of sterile frond thin, flat, ½ mm wide or nearly so.
43. Fronds widest below middle, narrowed gradually to apex; veins distinct  
34. *E. negrosensis*
43. Fronds widest at middle, apex obtuse-angled; veins not distinct  
35. *E. planicosta*
42. Pale margin of sterile frond very narrow, usually reflexed.
44. Scales to 1½ mm wide, not flat.
45. Scales straight and rather stiff with inrolled edges; frond commonly 35 cm or more long, narrowly elliptic . . . . . 36. *E. callifolium*
45. Scales thin, crisped throughout, with long twisted hair-points; frond rarely 30 cm long, broadly elliptic . . . . . 37. *E. commutatum*
44. Scales wider, flat or little crisped, edges not inrolled.
46. Stipe of fertile frond not much longer than stipe of sterile.
47. Scales commonly 20–25 by 2½–3 mm . . . . . 38. *E. malayense*
47. Scales not over 10 mm long.
48. Rhizome-scales with many spreading marginal hairs; scales on lamina to 1 mm long, narrow . . . . . 40. *E. sordidum*
48. Rhizome-scales with few marginal hairs; scales on lamina stellate, under ½ mm long.
49. Costa broad and not prominent beneath; rhizome-scales firm  
41. *E. novoguineense*
49. Costa prominent beneath; rhizome-scales thin, with isodiametric cells  
43. *E. favigerum*
46. Stipe of fertile frond at least twice as long as stipe of sterile.
50. Scales 6 by 2½ mm, sterile frond short-acuminate . . . . . 39. *E. recommitatum*
50. Scales to 15 by 2 mm; sterile frond broadly pointed . . . . . 42. *E. robinsonii*
40. Apex of sterile frond distinctly rounded.
51. Rhizome-scales 3–5 mm long; fertile frond c. 8 by 3.3 cm . . . . . 7. *E. pullenii*
51. Rhizome-scales 10–15 mm long; fertile frond at least 6 times as long as wide.
52. Spores 52–59 µm long with broad perispore of few folds; stipe of fertile frond twice as long as that of sterile; edge of lamina thick, deflexed; lamina greenish when dry.
53. Lamina of sterile frond to 30 by 5 cm, stipe 5–8 cm long. . . . . 44. *E. sumatranum*
53. Lamina of sterile frond 35–55 cm long, stipe 14–18 cm long . . . . . 45. *E. indrapuræ*
52. Spores c. 37 µm long with narrow much-folded perispore; stipe of fertile fronds not much longer than of sterile; pale edge of lamina thin; fronds brownish when dry, thick, rigid  
46. *E. spongophyllum*
1. Small scales on frond (except near edge) ± orbicular, pale, with marginal teeth or hairs each of one thick-walled cell, not glandular; rhizome-scales always narrow, rigid, dark, glossy.
53. Scales on upper surface conspicuously stellate; sterile fronds often to 3 cm wide.
54. Scales on lower surface very small, each with 3–5 marginal hairs ½–1 mm long spreading away from frond-surface . . . . . 47. *E. blumeianum*
54. Scales on lower surface with a distinct lamina (flat or not) bearing more slender and shorter marginal hairs.
55. Scales of lower surface mostly elongate, bullate at base; on upper surface flat, those near margin elongate, forming a conspicuous spreading fringe . . . . . 48. *E. miniatum*
55. Scales of lower surface small, orbicular, flat or cup-shaped; scales of upper surface flat, about same size as on lower, those near margin not forming a conspicuous fringe  
49. *E. heterolepium*
53. Scales on upper surface with very short marginal hairs; sterile fronds c. 1 cm wide  
50. *E. resiniferum*

**1. *Elaphoglossum bolanicum* ROSENST.** in Fedde, Rep. 12 (1913) 180; v.A.v.R. Handb. Suppl. (1917) 427; COPEL. Philip. J. Sc. 78 (1949) 403. — Type: KEYSSER B.62, Bolan Mts, NE. New Guinea (S-PA). — Fig. 15.

*Rhizome* long-creeping, 1–1½ mm Ø; fronds 1–2 cm apart; scales thin, light brown, to 3 by 1 mm, edges with few short hairs; phyllopodia 6–8 mm long. *Sterile frond*: stipe 2–3½ cm; lamina 4–7 cm by 9–13 mm, widest at or below middle, gradually narrowed distally, apex acute, towards base similarly narrowed and then decurrent as a narrow wing for 10–15 mm; pale thin edge distinct; veins visible but not prominent; scales on both surfaces minute, dark brown, with short spreading hairs. *Fertile frond*: stipe 4–6 cm; lamina 2½–3 cm by 9–12 mm, widest ⅓ from base, narrowed to blunt apex and more abruptly to base, with narrow basal wing as sterile.

Distr. *Malesia*: NE. New Guinea (3 collections).

Ecol. At 2400–3000 m.

Note. The type specimen has only one sterile frond, which is smaller than the fertile ones; sterile fronds are described above from the other collections, which agree exactly in rhizome-scales and in fertile fronds with the type.



Fig. 15. *Elaphoglossum bolanicum* ROSENST. a. Habit, 2 sterile fronds, 1 fertile,  $\times \frac{2}{3}$ , b. scale from rhizome,  $\times 13$ , c. scale from surface of frond,  $\times 27$  (HOOGLAND & SCHODDE 7699).

**2. *Elaphoglossum habbemense* COPEL.** Univ. Cal. Publ. Bot. 18 (1942) 226; Philip. J. Sc. 78 (1949) 403, pl. 7. — Type: BRASS 9083, W. New Guinea, Lake Habbema (GH).

*Rhizome* long-creeping, c. 2 mm Ø, fronds 1–2 cm apart; scales light brown, translucent, closely imbricating, 3 by 2 mm, ovate, acute, subentire; phyllopodia to 8 mm long. *Sterile frond*: stipe 2–3 cm; lamina 3½–6 cm by 8–15 mm, thinly coriaceous to rigid, elliptic, apex bluntly pointed, base narrowly cuneate and then decurrent as a wing 10–15 mm; thin edge distinct, narrow; veins visible or not; costa slightly prominent beneath; scales on costa beneath rather persistent, narrowly acuminate from a broad base, ½–1½ mm long; scales on lower surface of lamina stellate, smaller. *Fertile frond*: stipe 1½–3½ cm; lamina 2½–4½ cm by 7–10 mm, shape as sterile.

Distr. *Malesia*: New Guinea (3 collections).

Ecol. In a cushion of hepatics on exposed tree-branch, 3225 m.

**3. *Elaphoglossum pumilum* LAM & VERHEY,** Blumea 5 (1945) 559, f. 2. — Type: MONOD DE FROIDEVILLE 253, Lompobatang, Bonthain, S. Celebes (L; dupl. in BO).

*Rhizome* slender, creeping, bearing fronds ½–1 cm apart; scales brown, thin, entire, ovate-acute, to 2½ mm long; phyllopodia 5 mm long. *Sterile frond*: stipe 2 cm; lamina to 2 by 1 cm, thinly coriaceous, ovate, base shortly decurrent as a narrow wing, apex blunt, rounded; thin pale edge narrow,  $\pm$  reflexed; veins slightly prominent beneath; costa hardly prominent on lower surface; no superficial scales seen. *Fertile frond*: stipe 3½–6 cm; lamina to 20 by 9 mm, shape as sterile.

Distr. *Malesia*: S. Celebes. Only known from type collection.

Ecol. At 2500 m.

**4. *Elaphoglossum hellwigianum* ROSENST.** Nova Guinea 8 (1912) 731; v.A.v.R. Handb. Suppl. (1917) 423; COPEL. Philip. J. Sc. 78 (1949) 403. — Type: VON RÖMER 1273, Hellwig Mts, W. New Guinea (S-PA; dupl. in BO).

*Rhizome* 2 mm Ø, fronds c. 1 cm apart; scales rigid, dark, glossy, narrow, acuminate, 2–3 mm long, edges with short teeth or sparse short hairs; phyllopodia not distinct. *Sterile frond*: stipe 1–1½ cm; lamina rigid-coriaceous, 3 by 1½ cm, almost elliptical, base slightly decurrent, apex broadly pointed (fronds on a young plant obovate with much-decurrent bases); thin pale edge distinct; veins not visible; costa slightly prominent near base beneath; many scales on lower surface of young frond (mostly caducous), dark, elongate, with some marginal hairs. *Fertile frond*: stipe 3 cm; lamina 1½ by 1 cm, elliptic, base hardly decurrent; small dark glossy scales abundant among sporangia.

Distr. *Malesia*: W. New Guinea. Only known from type collection.

Ecol. Probably at 3000 m or more.

**5. *Elaphoglossum brunneum* COPEL.** Univ. Cal. Publ. Bot. 18 (1942) 226; Philip. J. Sc. 78 (1949) 405, pl. 10. — Type: BRASS 12808, Idenburg River, W. New Guinea (GH).

*Rhizome* bearing fronds 5–10 mm apart; scales dark brown, glossy, rigid, 6 by 1 mm, narrowed to a hair-tip; phyllopodia 10 mm long. *Sterile frond*: stipe 8–10 cm; lamina rigid, to 19 by 4 cm, widest below middle,  $\pm$  abruptly narrowed at base and



Fig. 16. *Elaphoglossum commutatum* (METT. ex KUHN) v.A.v.R. a. Habit,  $\times \frac{1}{2}$ . — *E. angulatum* (BL.) MOORE. b. Habit,  $\times \frac{1}{2}$ , c. margin of sterile frond,  $\times 5$  (a SURBECK 277, b-c L 908.331-949).

then slightly decurrent, more gradually to acute but not acuminate apex; pale edge c.  $\frac{1}{4}$  mm wide; veins just distinct; costa prominent and rounded beneath; scales on both surfaces appressed, dark, less than 1 mm long, elongate with a few short marginal hairs. *Fertile frond*: stipe 18 cm; lamina 12 by 2.2 cm, shape as sterile.

Distr. *Malesia*: W. New Guinea. Only known from type collection.

Ecol. Low epiphyte in rain-forest at 1200 m.

**6. *Elaphoglossum angulatum* (BL.) MOORE.** Ind. Fil. (1857) 5; v.A.V.R. Handb. (1908) 713; Suppl. (1917) 423; C.CHR. Gard. Bull. S. S. 7 (1934) 290; BACKER & POSTH; Varenfl. Java (1939) 250; TARD.-BL. & C.CHR. Fl. Gén. I.-C. 7, 2 (1941) 541; COPEL. Philip. J. Sc. 78 (1949) 405; Fern Fl. Philip. (1960) 278; SLEDGE, Bull. Brit. Mus. (Nat. Hist.) 4 (1967) 83. — *Acrostichum angulatum* BL. En. Pl. Jav. (1828) 101; Fl. Jav. Fil. (1828) 25, t. 6; FÉE, Hist. Acrost. (1845) 32; RACIB. Fl. Btzg 1 (1898) 47. — *Olfersia angulata* PRESL, Tent. Pterid. (1836) 234. — Type: BLUME, Java (L).

*E. minahassae* v.A.V.R. Handb. Suppl. (1917) 527; Bull. Jard. Bot. Btzg II, 28 (1918) 24. — *Acrostichum conforme* (non Sw.) CHRIST, Ann. Jard. Bot. Btzg 15 (1898) 174, p.p. — Type: KOORDERS 17097, Menado, Celebes (BO).

*E. dolichocaulon* v.A.V.R. Bull. Jard. Bot. Btzg III, 5 (1922) 203; BACKER & POSTH. Varenfl. Java (1939) 250. — Type: JESWIET 348, Mt Jang (BO).

*E. ogatai* C.CHR. Dansk Bot. Ark. 9, 3 (1937) 67. — Type: OGATA 59, Taiwan (BM).

*E. alstonii* TARD.-BL. Not. Syst. Paris 15 (1959) 433. — *Acrostichum laurifolium* (non THOUARS) FÉE, Hist. Acrost. (1845) 36, t. 7, f. 1. — Type: SIEBER, Mauritius (P).

*E. laurifolium* [non (THOUARS) MOORE] BEDD. Ferns S. India (1866) t. 200. — *E. latifolium* [non (Sw.) J.Sm.] BEDD. Handb. Ferns Br. India (1883) 416, p.p. incl. f. 248. — Fig. 16b, c.

*Rhizome* long-creeping, bearing fronds 1–3 cm apart; scales thin, light brown, 4 by 2–3 mm, triangular, tip blunt to acute, edges subentire; phyllopodia 1–2 cm long. *Sterile frond*: stipe 5–15 cm, when young scaly as rhizome; lamina thin but firm, 11 by 3 to 28 by 5 cm, narrowly elliptic (largest with sides parallel in middle part), apex short-acuminate, base slightly decurrent; thin edge nearly 1 mm wide, translucent; veins at a rather wide angle, distinct on lower surface, their ends joining a thickened submarginal band in which they bifurcate and form a  $\pm$  continuous vascular commissure; costa not very prominent beneath; mature fronds glabrous except for a few scales on or near costa beneath, as those on stipe but smaller. *Fertile frond*: stipe to 18 cm or more long; lamina 13 by 2.2 to 22 by  $3\frac{1}{2}$  cm, base more abruptly contracted than sterile, thin edge somewhat narrower.

Distr. E. tropical Africa, Madagascar, Réunion, Ceylon, S. India, Tonkin, Taiwan; throughout *Malesia* on higher mountains (not in the Malay Peninsula); New Hebrides.

Ecol. Epiphyte in low forest and sometimes on mossy rocks in  $\pm$  sheltered places, at 2000–3500 m.

Note. The sterile frond of the Bogor type specimen of *E. minahassae* has a damaged apex which has a falsely rounded appearance; a Leiden speci-

men of the same number has fronds typical of *E. angulatum*. This is the most widely distributed *Malesian* species.

**7. *Elaphoglossum pullenii* HOLTUM,** *Blumea* 14 (1966) 324. — Type: PULLEN 5034, *partim*, NE. New Guinea (L).

*Rhizome* creeping, fronds in each rank 1– $1\frac{1}{2}$  cm apart; scales light brown, firm, ovate-acuminate, 5 by  $1\frac{1}{2}$  mm, edges with few hairs; phyllopodia 1– $1\frac{1}{2}$  cm long. *Sterile frond*: stipe slender, 13–14 cm long, glabrescent; lamina thick, rigid, to 12 by 3 cm, almost evenly elliptical, base shortly decurrent, apex narrowly rounded; thin pale edge c.  $\frac{1}{4}$  mm wide; veins  $\pm$  distinct, not prominent; costa beneath broad, pale, hardly prominent; scales on lower surface red-brown, to 1 mm long, narrow with long marginal hairs near base, smaller ones stellate. *Fertile frond*: stipe 14 cm; lamina 6 by 2 to 8 by 3.3 cm, widest below middle, base abruptly narrowed and then decurrent 1 cm, apex broadly rounded.

Distr. *Malesia*: E. & NE. New Guinea.

Ecol. Epiphyte, low on trees in mossy forest at 3140–3300 m, growing with *E. angulatum*, a specimen of which was collected with the type.

**8. *Elaphoglossum sclerophyllum* v.A.V.R.** *Nova Guinea* 14 (1924) 22; COPEL. Philip. J. Sc. 78 (1949) 405. — Type: LAM 1793, W. New Guinea (BO; dupl. in L, U).

*E. fuscum* COPEL. Univ. Cal. Publ. Bot. 18 (1942) 226; Philip. J. Sc. 78 (1949) 406, pl. 12. — Type: BRASS 9088, W. New Guinea (MICH; dupl. in BM, BO, GH, K, L).

*E. laticuneatum* COPEL. Univ. Cal. Publ. Bot. 18 (1942) 226; Philip. J. Sc. 78 (1949) 405, pl. 9. — Type: BRASS & MEIJER-DREES 10032, W. New Guinea (GH).

*Rhizome* creeping, fronds 1–2 cm apart; scales rigid, dull brown to glossy dark brown, 4–6 by  $1\frac{1}{2}$  mm, apex acuminate, edges with teeth or stiff hairs; phyllopodia  $1\frac{1}{2}$ –2 cm long. *Sterile fronds*: stipe 4–15 cm long, pale, rather persistently scaly as rhizome; lamina thick, rigid, variable in shape, commonly 10–13 by  $2\frac{1}{2}$ – $3\frac{1}{2}$  cm, on some plants 8–10 by 4 cm, widest about middle or above it, apex narrowed to rounded tip, base cuneate and  $\pm$  decurrent (more so in small than in large fronds); thin edge pale,  $\frac{1}{4}$  mm wide; veins distinct or not; costa broad and slightly prominent beneath; scales on both surfaces at first abundant, to 1 mm long, dark, glossy, appressed, usually with some spreading marginal hairs. *Fertile frond*: stipe 15–30 cm; lamina commonly 9–14 cm long,  $2\frac{1}{2}$ – $3\frac{1}{2}$  cm wide, of one specimen 8 by 4 cm.

Distr. *Malesia*: New Guinea.

Ecol. On terrestrial moss-cushions or epiphytic in open thickets at c. 3000 m (several collections).

Note. A specimen at Leiden from W. New Guinea (VERSTEEGH BW 12609, *partim*, Arfak Mts, 1750 m) has apparently a short thick rhizome with close fronds which are larger than those of the type (sterile to 18 by 4, fertile to 20 by 2 cm) but in shape and scaliness very similar. BRASS collections from near Lake Habbema at 2000 m (11038, 13040) are similar. These may constitute a distinct species which occurs at about 2000 m.

**9. *Elaphoglossum repens* COPEL.** Univ. Cal. Publ. Bot. 18 (1942) 226; Philip. J. Sc. 78 (1949) 406, pl. 11. — Type: BRASS 12124, W. New Guinea, near Idenburg River (MICH; dupl. in GH, L).

*Rhizome* 2 mm Ø, creeping; fronds  $1\frac{1}{2}$ –2 cm apart; scales dark brown, glossy, rigid, entire, to 3 by  $\frac{2}{3}$  mm, narrowly acuminate; phyllopodia 1 cm long. *Sterile frond*: stipe slender, pale, 3–8 cm long; lamina thinly coriaceous, 12 by  $2\frac{1}{2}$ –3 cm, widest at middle, base ± decurrent, apex gradually narrowed to a ± broadly rounded tip; pale thin edge distinct; veins not prominent, sometimes distinct; costa slightly prominent beneath; surfaces glabrescent. *Fertile frond*: stipe 9–14 cm; lamina probably to 9 by  $1\frac{1}{2}$  cm (larger frond broken), apex narrowly rounded, base a little decurrent.

Distr. *Malesia*: W. New Guinea. Only known from type collection.

Ecol. Frequent low epiphyte in mossy forest, 1800 m.

**10. *Elaphoglossum ophioglossoides* (GOLDM.) HOLTUM**, Kalikasan, Philip. J. Biol. 3 (1974) 197. — *Acrostichum ophioglossoides* GOLDM. Nova Acta 19, Suppl. 1 (1843) 451. — Type: MEYEN s.n., Manila (B).

*E. merrillii* CHRIST, Philip. J. Sc. 3 (1908) Bot. 275; v.A.v.R. Handb. Suppl. (1917) 424; COPEL. Fern Fl. Philip. (1960) 279. — Type: MERRILL 5853, Mt Halcon, Mindoro (P; dupl. in GH).

*Rhizome* short, fronds very close; scales medium brown, rather thin and crisped, hair-pointed, to 15 by 1 mm, edges with a few spreading hairs; phyllopodia less than 1 cm. *Sterile frond*: stipe 3–8 cm long with a wing c. 1 mm wide throughout, edge of wing pale cartilaginous as edge of lamina; lamina coriaceous, to 26 cm long, largest fronds  $3\frac{1}{2}$ –5 cm wide, usually widest above middle, narrowed gradually to base and more abruptly to broadly pointed or almost rounded apex; thin pale edge c.  $\frac{1}{2}$  mm wide; costa beneath slightly prominent near base, distally flat; veins faintly visible; lower surface glabrescent, residual scales stellate, small. *Fertile frond*: stipe to 8 cm; lamina c. 10 by  $1\frac{1}{2}$ –2 cm.

Distr. *Malesia*: Philippines (Luzon, Mindoro, Samar).

Ecol. In forest, at 500 m, and probably higher. Note. In 'Reise um der Erde' 2 (1855) 264–270, MEYEN described his ascent of Mt Sembrano above Laguna (480–510 m) from Manila; he appears not to have climbed higher mountains. The above description is taken mainly from the type collection of *E. merrillii* (P, GH); MEYEN's type is smaller but certainly represents the same species.

**11. *Elaphoglossum latemarginatum* HOLTUM**, Blumea 14 (1966) 322. — Type: BRASS 24896, Papua, Goodenough I. (A).

*Rhizome* short; scales 8–10 by  $1\frac{1}{2}$  mm, dull medium brown, rather thin, acuminate, apices sometimes a little twisted, edges with scattered hairs; phyllopodia 5 mm long. *Sterile frond*: wingless stipe pale, c. 1 cm long; lamina thinly coriaceous, 19–23 by 2.6–3.3 cm, widest  $\frac{1}{3}$  from apex, narrowed very gradually to base which forms a gradually narrowing wing so that junction with stipe is indistinct, apex shortly acuminate; thin

pale edge  $\frac{1}{2}$  mm wide; veins distinct on lower surface; costa pale, not prominent on lower surface; scales on surface appressed, ± stellate with several short arms, mostly less than 1 mm Ø including arms. *Fertile frond*: stipe 4 cm; lamina 17 by 1.6 cm, shape as sterile, thin pale margin 1 mm wide.

Distr. *Malesia*: E. New Guinea (Goodenough I.). Only known from type collection.

Ecol. Common low epiphyte on mossy trees, 1600 m.

**12. *Elaphoglossum pellucido-marginatum* (CHRIST) C. CHR.** Bot. Jahrb. 66 (1933) 65. — *Acrostichum pellucido-marginatum* CHRIST, Verh. Naturf. Ges. Basel 11 (1895) 255. — *Acrostichum gorgoneum* (non KAULF.) CHRIST, Ann. Jard. Bot. Btzg 15 (1898) 175, p.p.; v.A.v.R. Handb. (1908) 712, p.p. — Type: SARASIN 947, Celebes (BAS).

*Rhizome* scales 5 by 1 mm, medium brown, ovate-acute; phyllopodia 5–10 mm long. *Sterile frond*: stipe (unwinged) to  $2\frac{1}{2}$  cm; lamina of largest fronds 17 by  $1\frac{1}{2}$  to 35 by 4 cm, firm but not thick, widest in upper third, gradually narrowed to decurrent base and more abruptly to narrowly rounded or broadly pointed apex; translucent edge c.  $\frac{3}{4}$  mm wide; veins not very distinct, their free apices thickened; scales on lower surface very small, stellate. *Fertile frond*: stipe  $3\frac{1}{2}$ –10 cm; lamina almost as large as sterile, apex sometimes more distinctly rounded.

Distr. *Malesia*: North to SE. and SW. Celebes.

Ecol. Epiphyte, at 1200–2400 m.

Note. The species *E. gorgoneum* (KAULF.) BRACK. is confined to Hawaii (see p. 313).

**13. *Elaphoglossum thamnopteris* HOLTUM**, Blumea 14 (1966) 326. — Type: BRASS 22990, Papua, Mt Dayman, 1650 m (A).

*Rhizome* short; scales 10–15 by 3–4 mm, rather thin, light brown, subentire, not acuminate; phyllopodia c. 1 cm long. *Sterile frond*: lamina rather thin, of specimens seen to 57 by  $5\frac{1}{2}$  cm (to 80 cm long, *fide* BRASS), widest above middle, very gradually narrowed to joint with phyllopodium, apex acuminate; thinner edge hardly decoloured; veins distinct and slightly prominent on both surfaces, their apices joining in a series of submarginal arcs as in *Asplenium nidus*; costa prominent beneath throughout; scales on surfaces scattered, mostly under  $\frac{1}{2}$  mm, with a few short marginal hairs and spherical cells near point of attachment. *Fertile frond*: stipe 15 cm; lamina 25 by 2 cm, base long-decurrent, apex shortly blunt-pointed.

Distr. *Malesia*: New Guinea, Ceram.

Ecol. Epiphyte (type in *Nothofagus* forest), at 1500–1700 m.

Note. A specimen from 2900 m in NE. New Guinea (T. G. WALKER 7571) has fronds to 35 by 4 cm, thicker than those of the type, but appears to belong to this species.

**14. *Elaphoglossum idenburgensis* HOLTUM**, Blumea 14 (1966) 321. — Type: BRASS 12283, W. New Guinea (GH; dupl. in MICH).

*Rhizome* short; scales dark, glossy, rigid, to 4 by 2 mm; phyllopodia 12–17 mm long. *Sterile frond*: lamina rigid, decurrent to joint with phyllopodium,  $21\frac{1}{2}$ –1.8 cm, widest about middle,

base rather narrowly decurrent, apex acuminate; thin margin not decoloured, narrow, reflexed; veins rather obscure; costa prominent beneath; scales on both surfaces sparse, dark, appressed, usually entire. *Fertile frond*: stipe 6 cm; lamina 12 by 1.1 cm, base decurrent, apex bluntly pointed.

*Distr. Malesia*: W. New Guinea. Only known from type collection.

*Ecol.* In mossy forest on old log, 1800 m.

**15. *Elaphoglossum archboldii* COPEL.** Univ. Cal. Publ. Bot. 18 (1942) 226; Philip. J. Sc. 78 (1949) 404, pl. 8. — Type: BRASS 13220, W. New Guinea (GH).

*Rhizome* short; scales dark, glossy, rigid, flat, ovate, 4–5 by 1–1½ mm; phyllopodia 2–4 cm long. *Sterile frond*: unwinged stipe 1–3 (to 8?) cm long, above which is a narrowly winged part 4–20 cm long below lamina; lamina thinly coriaceous, 25–50 by 2½–5 cm, widest about middle, gradually narrowed to narrowly cuneate base, apex acuminate; thin edge not distinct; veins slightly prominent, their ends joining in submarginal arcs (at least near base of frond); costa prominent beneath; scales on lower surface not persistent, very small, stellate with arms of 2–3 cells. *Fertile frond*: stipe 10–30 cm long; lamina 20–30 cm long including a narrow sterile decurrent base, 2.2 cm wide.

*Distr. Malesia*: W. New Guinea.

*Ecol.* Epiphytic at 850–2000 m (type, at 850 m, a low epiphyte; specimen from 2000 m an epiphyte in moss cushions).

**16. *Elaphoglossum apiculatum* HOLTUM,** Blumea 14 (1966) 320. — Type: BRASS 13624, W. New Guinea (GH).

*Rhizome* short; scales dark, glossy, rather broad (no complete ones seen); phyllopodia 1½–2 cm long. *Sterile frond*: unwinged stipe less than 2 cm long; lamina (including basal wing) to 30 by 4.7 cm, thinly coriaceous, the main part (18 cm long) elliptic with a narrow triangular apiculus 5 mm long, at the base rather abruptly narrowed to the basal wing; thin edge not distinct; veins slightly prominent on both surfaces, sometimes anastomosing at their tips; costa strongly prominent beneath; scales on lower surface of lamina not seen, on lower surface of costa small, stellate, also a few larger appressed ovate dark glossy scales hardly 1 mm long. No complete *fertile frond* seen; one frond fertile in distal 8 cm, this fertile part contracted, 2.3 cm wide, basal part shaped as sterile but narrower.

*Distr. Malesia*: W. New Guinea. Only known from type collection.

*Ecol.* Epiphyte in rain-forest, at 900 m.

*Note.* This specimen is near *E. archboldii*, but differs in the shape of both apex and base of sterile fronds, characters which are usually distinctive in this genus.

**17. *Elaphoglossum annamense* C. CHR. & TARD.-BL.** Not. Syst. Paris 8 (1939) 209. — Type: POILANE 23783, S. Vietnam (P).

*E. decurrens* var. *crassum* C. CHR. Gard. Bull. S. S. 7 (1934) 290, p. p. — Fig. 17.

*Rhizome* short; scales dense, to 20 mm long, 2 mm wide at base, distally very narrow, hair-pointed, somewhat red-brown, older ones darker

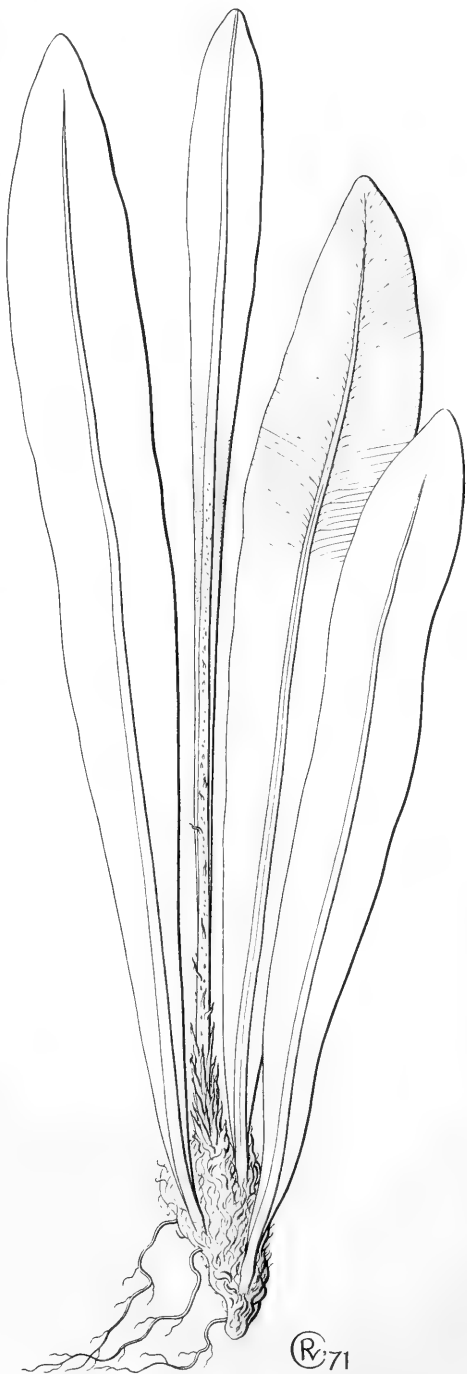


Fig. 17. *Elaphoglossum annamense* C. CHR. & TARD.-BL. Three sterile fronds, one fertile,  $\times \frac{1}{2}$  (KOSTERMANS 2412).



Fig. 18. *Elaphoglossum norrisii* (HOOK.) BEDD. a. Plant with 1 fertile and 2 sterile fronds,  $\times \frac{1}{2}$ , b-c. scales from lower surface of frond,  $\times 40$ . — *E. melanostictum* (BL.) MOORE. d. Plant with 1 fertile and 3 sterile fronds,  $\times \frac{1}{2}$ , e. scale from lower surface of frond,  $\times 32$  (a BACKER 10998, d RAAP 236).



and dull, with some slender marginal hairs; phyllopodia 1–1½ cm long. *Sterile frond*: stipe to 1½ cm long; lamina rather thick, rigid when dry, to 30 by 5–6 cm, widest above middle, tapering gradually to decurrent base and rather abruptly to broadly pointed or slightly rounded apex; thin pale edge very narrow; veins not distinct; costa beneath broad, slightly prominent; scales on lower surface sparse, stellate, under 1 mm Ø including rays, with some spherical cells near point of attachment. *Fertile frond*: fertile part of lamina to 18 by 2½ cm, gradually narrowed to base which continues as a sterile wing 10 cm long almost to phyllopodium, apex abruptly narrowed and rounded.

Distr. S. Vietnam; in *Malesia*: Borneo (Sarawak, Sabah), Moluccas (Ceram) (?), W. New Guinea.

Ecol. Epiphyte at 1800–2100 m (1000–1800 m in Vietnam).

Note. Some specimens from S. Vietnam have sterile fronds to 40 cm long and fertile to 20 by 4 cm; I have seen none so large in Malesia, and the above description is mainly from Malesian specimens.

**18. *Elaphoglossum melanostictum* (BL.) MOORE**, Ind. Fil. (1862) 361; v.A.v.R. Handb. (1908) 716; Suppl. (1917) 427; BACKER & POSTH. Varenfl. Java (1939) 249. — *Acrostichum melanostictum* BL. Fl. Jav. Fil. (1829) 26, t. 7. — Type: VAN HASSELT, Java (L).

*Acrostichum lessonii* METT. in Kuhn, Linnaea 36 (1969) 60, excl. pl. LESSON. — Lectotype: KORTHALS s.n., Sumatra (B).

*Acrostichum beccarianum* BAKER, Malesia 3 (1886) 27. — *E. beccarianum* C. CHR. Ind. Fil. (1905) 303; v.A.v.R. Handb. (1908) 714. — Type: BECCARI s.n. Nov. 1865, Kuching, Sarawak (FI; dupl. in K).

*E. basilanicum* COPEL. Philip. J. Sc. 11 (1916) Bot. 41; v.A.v.R. Handb. Suppl. (1917) 425; COPEL. Fern Fl. Philip. (1960) 280. — Type: REILLO BS 16232, Basilan (MICH; dupl. in P).

*E. peninsulare* HOLTUM, Gard. Bull. S. S. 11 (1947) 270; Rev. Fl. Mal. 2 (1954) 456, f. 266. — Type: ERYL SMITH 2021, Patani, Thailand (SING; dupl. in K).

*Acrostichum apodum* (non KAULF.) FÉE, Hist. Acrost. (1845) 42, pl. jav. tantum.

*Acrostichum norrisii* (non HOOK.) CESATI, Atti Acad. Napoli 7, pt 8 (1876) 31. — Fig. 18d, e.

*Rhizome* short; scales dark brown, to 10 mm long (often shorter), 1 mm wide, acuminate, edges with short stiff hairs; phyllopodia 1–2 cm long. *Sterile frond*: stipe 0–3 cm; lamina thinly coriaceous, to 40 by 6–7 cm, widest ⅓ from apex, narrowed gradually to long-decurrent base, apex broadly but distinctly pointed; thinner edge narrow, not decoloured; veins usually distinct; costa rounded and prominent beneath; scales on lower surface light brown, irregularly stellate with slender arms to 1–1½ mm long, lacking conspicuous spherical cells near point of attachment. *Fertile frond*: stipe 7–15 cm; lamina 11–30 cm long, 1.3–3.7 cm wide, shape as sterile.

Distr. Peninsular Thailand and *Malesia*: Sumatra, Malay Peninsula, Java, Borneo, Philippines (Basilan, Samar, Negros, Mindanao).

Ecol. Epiphytic on tree-trunks in forest at 100–1700 m.

Notes. *E. basilanicum* was described from rather small sterile plants, but in shape of frond and scales agrees closely with other specimens. The species *Acrostichum lessonii* was based in part on specimens collected by LESSON on Vanicoro (Santa Cruz I.) and partly on a specimen from Sumatra, coll. KORTHALS. The latter alone has a fertile frond, and its sterile ones are much larger than those from Vanicoro. The description agrees with the Sumatran plant, which should thus be the type; the Vanicoro plant is different and I cannot identify it.

A collection of GRABOWSKY (s.n. Jan. 1882; B, BM) from SE. Borneo, is rather intermediate both in scales and frond-form between *E. melanostictum* and *E. norrisii*; sterile fronds to 20 by 3 cm, fertile with long stipe as *melanostictum* but only 1 cm wide and very long-decurrent. I regard these specimens as small *E. melanostictum*.

**19. *Elaphoglossum heterostipes* HOLTUM**, Blumea 14 (1966) 321. — Type: ENDERT 4424, Borneo, W. Kutai, Mt Kemul (BO).

*Rhizome* short; scales medium brown, thin, 5–7 by 1½–2 mm, subentire, apex narrowed but not acuminate; phyllopodia 1 cm long. *Sterile frond*: unwinged stipe 0–5 cm; lamina thinly coriaceous, to 38 by 4.8 cm, widest above middle, base narrowly long-decurrent, apex narrowed to acute (not acuminate) tip; thin edge distinct but not decoloured; costa beneath distinctly prominent; veins slightly prominent on both surfaces, their swollen ends distinct; scales on lower surface numerous, very small, dark, lacking long hairs. *Fertile frond*: stipe 25–30 cm; lamina 25 by 2 cm, shape as sterile.

Distr. *Malesia*: E. Borneo. Only known from type collection.

Ecol. In forest at 1800 m.

Note. This species has sterile fronds closely similar to those of *E. melanostictum* in shape, but differs in scales on rhizome and fronds and in the very long stipe of fertile frond. ENDERT collected *E. melanostictum* on the same mountain at 1600 m.

**20. *Elaphoglossum calanasanicum* HOLTUM**, Kalikasan, Philip. J. Biol. 3 (1974) 196. — Type: M. G. PRICE 2933, Luzon, Kalinga-Apayao Prov., Calanasan (K, PNH).

*Rhizome* short; scales to 15 by 1 mm, brown, glossy, crisped, with few marginal hairs; phyllopodia 1 cm long. *Sterile frond*: stipe to 2 cm; lamina to 34 by 2.7 cm, widest about middle, gradually narrowed to base and more abruptly to acute apex; costa almost flat both sides; veins faintly visible, not prominent; cartilaginous edge hardly ¼ mm wide. *Fertile frond*: unwinged stipe to 2 cm long, then a narrowly winged portion 7–8 cm long, gradually widening upwards, lamina 12–15 by 2 cm, widest at middle, narrowed about equally to acute apex and to base, scales on upper surface to ½ mm long, stellate, end cells of arms ellipsoid.

Distr. *Malesia*: Philippines (Luzon), only known from the type.

Ecol. At 1400 m, abundant, growing with *E. ophioglossoides*.

**21. *Elaphoglossum norrisii* (HOOK.) BEDD.** Ferns Br. India pt 23 (1870) *addendum*; Handb. Ferns

Br. India (1883) 418; Suppl. (1892) 104; v.A.v.R. Handb. (1908) 716. — *Acrostichum norrisii* Hook. Spec. Fil. 5 (1864) 215. — *E. melanostictum* [non (BL.) MOORE] HOLTUM, Rev. Fl. Mal. 2 (1954) 455, f. 265. — Type: NORRIS, Penang (K). — Fig. 18a–c.

*Rhizome* short; scales to 10 by  $1\frac{1}{2}$  mm, rather dark red-brown, thin, tapering to a fine point, edges with irregular teeth and hairs; phyllopodia short. *Sterile frond*: no stipe; lamina 20–40 by 2–4 cm, thinly coriaceous, usually widest above middle, very gradually narrowed to base, more shortly to rather narrow but rounded apex; thin pale edge very narrow; veins faintly visible; costa beneath broad and little prominent; scales on lower surface stellate with short arms and conspicuous spherical cells near point of attachment. *Fertile frond*: stipe commonly to 2 cm, sometimes longer; lamina commonly to 20 by 1 cm, widest seen 1.3 cm.

Distr. *Malesia*: Sumatra, Malay Peninsula, Borneo, W. Java, W. New Guinea.

Ecol. In forest, on mossy tree-trunks and rocks, at 60–1500 m.

**22. *Elaphoglossum apoense* HOLTUM**, Blumea 14 (1966) 320. — Type: EDANO PNH 710, Mt Apo, Mindanao (MICH). — Fig. 20d.

*Rhizome* short; scales dark, rigid, glossy, somewhat contorted, 5 by  $\frac{1}{2}$  mm, hair-pointed with some lateral stiff hairs; phyllopodia 1 cm long. *Sterile frond*: stipe 22 cm long, pale, bearing scales of various sizes from very small to 5 mm long, the latter as those on rhizome but narrower; lamina thinly coriaceous,  $19\frac{1}{2}$  by 3 cm, widest  $\frac{1}{3}$  from apex, tapered gradually towards base which is not decurrent, towards apex narrowed a little and then rounded; thin pale edge very narrow; veins distinct; costa prominent and rounded beneath; scales on both surfaces abundant, dark brown, glossy, very narrow, mostly 1–2 mm long, with spreading rigid marginal hairs each consisting of one dark cylindrical cell with a small pale cell at its apex (not seen at  $\times 10$  magnification); many scales 1 mm long attached close to edge of lamina and spreading beyond it. *Fertile frond* not seen.

Distr. *Malesia*: Philippines (Mindanao), Papua New Guinea (Mt Albert Edward, T. NAIKAKE 552).

Ecol. In mossy forest, at 2100 m.

**23. *Elaphoglossum vepiferum* HOLTUM**, Blumea 14 (1966) 326. — Type: CLEMENS 7417, NE. New Guinea, Morobe District, Sambanga (B; dupl. in GH sterile).

*Rhizome* creeping, bearing fronds to 8 mm apart in each rank; scales as in *E. apoense*; phyllopodia 10–15 mm long. *Sterile frond*: stipe 15–25 cm, rather persistently scaly with narrow dark glossy scales to 1 mm long with rigid short marginal hairs; lamina to at least 20 by 2.2 cm, thinly coriaceous, widest above the middle, apex narrowed slightly and rounded, base rather narrowly cuneate, not long-decurrent; pale edge firm, distinct; veins just visible; costa slightly prominent beneath; scales on lower surface of costa dark, very narrow,  $\frac{1}{2}$ –1 mm long, with stiff marginal hairs as in *E. apoense*; smaller paler scales with similar rigid hairs at first abundant on both surfaces, those near edge  $\frac{1}{2}$  mm long and forming a short tangled fringe

spreading beyond edge of lamina. *Fertile frond*: stipe 17 cm; lamina 14 by 1.4 cm, shape as sterile.

Distr. *Malesia*: E. New Guinea. Only known from type collection.

Ecol. In forest, at 1500–1800 m.

**24. *Elaphoglossum nigripes* HOLTUM**, Blumea 14 (1966) 323. — Type: PULLE 493, W. New Guinea, Mt Paramales (BM; dupl. in BO, L, U).

*Rhizome* creeping, rather slender, fronds close; scales dark, glossy, apparently 3 by 1 mm, not slender-tipped; phyllopodia 5 mm long. *Sterile frond*: stipe 5 cm, covered when young with appressed small dark entire scales; lamina thinly coriaceous, 25–40 by 1.8–2 $\frac{1}{2}$  cm, widest above middle, very gradually narrowed to decurrent base, also gradually to narrowly rounded apex; thin edge very narrow, reflexed when dry; veins  $\pm$  distinct; costa slender and prominent beneath; scales on costa beneath small, appressed, ovate-acute, dark, glossy; scales on lamina few, small, dark, appressed, with a few spreading hairs 2–3 cells long. *Fertile frond*: stipe 10 cm; lamina to 25 by 1.3 cm, shape as sterile, with rather abruptly narrowed blunt apex.

Distr. *Malesia*: W. New Guinea. Only known from two collections.

Ecol. In forest, at 1100–2500 m.

**25. *Elaphoglossum melanochlamys* HOLTUM**, Blumea 14 (1966) 322. — Type: EYMA 5408, W. New Guinea, Wissel Lakes (BO; dupl. in L).

*Rhizome* short; scales mostly black, rigid, glossy, 5 mm long, less than 1 mm wide, acuminate, edges short-toothed or with some stiff hairs; phyllopodia to 1 cm long. *Sterile frond*: stipe 3–5 cm long, pale, rather persistently scaly, scales as rhizome, narrow, spreading, with more conspicuous marginal hairs; lamina rigid, drying rather pale, 15–21 by 1.6 cm, sides parallel for most of length, narrowed rather abruptly to non-decurrent base and to narrowly rounded apex; pale edge distinct,  $\frac{1}{2}$  mm wide; veins obscure; costa beneath broad, pale, slightly prominent; scales on lower surface abundant, as those on stipe but smaller, mostly 1–3 mm long. *Fertile frond*: stipe 5 cm; lamina 15 by 1.4 cm; abundant scales among sporangia.

Distr. *Malesia*: W. New Guinea. Only known from type collection.

Ecol. Probably at over 2000 m.

**26. *Elaphoglossum nesioticum* HOLTUM**, Blumea 14 (1966) 323. — Type: BRASS 24882, Goodenough I. (A).

*Rhizome* short; scales dark, glossy, rigid, c. 7 mm long, hardly 1 mm wide, somewhat crisped, marginal hairs few; phyllopodia 1 cm long. *Sterile frond*: stipe 6–8 cm; lamina thin, 20–37 by 1–3.8 cm, widest about middle, narrowed gradually to decurrent base and to narrow slightly acuminate apex; thin edge very narrow, deflexed; veins slightly prominent, apices sometimes anastomosing; costa beneath slightly prominent; surfaces glabrescent. *Fertile frond*: stipe 8 cm; lamina 19 by  $1\frac{1}{2}$  cm, shape as sterile.

Distr. *Malesia*: E. New Guinea (Goodenough I.) (4 collections).

Ecol. Epiphyte in mossy forest, at 1500–1600 m.

27. *Elaphoglossum angustifrons* HOLTUM, Blumea 14 (1966) 319. — Type: WOMERSLEY NGF 11272, NE. New Guinea, Minj (LAE; dupl. in A, K).

*Rhizome* short; scales dark, glossy, flat, to 6 by 2 mm, subentire, not long-acuminate; phyllopodia 2–3 cm long. *Sterile frond*: stipe 5–10 cm, rather pale, at first with spreading scales as rhizome, persistent scales very small, dark brown, entire or with a few hairs; lamina thinly coriaceous, drying dark, 25–35 by  $1\frac{1}{2}$ –2.3 cm, sides parallel for most of their length, base very narrowly cuneate and  $\pm$  decurrent, apex short-acuminate; thin edge very narrow, not pale; veins distinct, mostly with free thickened tips, occasionally joining near margin; costa pale and prominent beneath; scales persistent on lower surface, very small, dark, with a few short hairs which seem often abraded. *Fertile frond*: stipe 10–15 cm; lamina 16–20 by 1.2– $1\frac{1}{2}$  cm.

Distr. *Malesia*: E. New Guinea. Only known from type collection.

Ecol. At 2100–2400 m.

Note. This has the aspect of *E. heterolepium*, but very different scales, and appears to be nearly related to *E. archboldii*.

28. *Elaphoglossum pallescens* HOLTUM, Blumea 14 (1966) 323. — Type: BRASS 22879, Papua, Mt Dayman (A).

*Rhizome* short; scales dark brown, glossy, c. 10 by  $1\frac{1}{2}$  mm, rigid, flat, hair-pointed, with short marginal teeth and slender marginal hairs; phyllopodia 1 cm long. *Sterile frond*: stipe 9–12 cm, pale; lamina rigid, drying pale, to at least 21 cm long, 2.8–4 cm wide, edges parallel in middle part, tapering about equally to slightly acuminate apex and slightly decurrent base; decoloured edge very narrow, reflexed; veins obscure; costa broad and slightly prominent beneath; scales on lower surface dark, appressed,  $\pm$  stellate with arms of several cells, in all to  $\frac{1}{2}$  mm wide; upper surface with scattered small pits in which are shrivelled scales. *Fertile frond*: stipe 15 cm; lamina 15 by  $2\frac{1}{2}$  cm, base rather abruptly narrowed and slightly decurrent.

Distr. *Malesia*: E. New Guinea (2 collections).

Ecol. Low on mossy tree in forest, 1800–2230 m.

29. *Elaphoglossum arachnoideum* HOLTUM, Blumea 14 (1966) 320. — Type: BRASS 24541, Goodenough I. (A).

*Rhizome* short; scales 10 by  $1\frac{1}{2}$  mm, acuminate, rather dull medium brown, stiff, subentire, somewhat twisted; phyllopodia c. 1 cm long. *Sterile frond*: stipe 20 cm, rather persistently scaly as rhizome but scales thinner; lamina firm but rather thin, 21 by 5.8 cm, widest in middle, almost elliptical, base slightly decurrent, apex rounded but not broadly; thin edge not sharply distinct; veins just distinct; costa beneath slightly prominent only near base; lower surface rather persistently scaly, many scales 2–3 mm long, very narrow, pale brown with a few marginal hairs, also abundant much smaller scales; scales near margin a little wider and projecting 2–3 mm, mostly abraded. *Fertile frond*: stipe 22 cm; lamina 12 by 3 cm, shape as sterile.

Distr. *Malesia*: E. New Guinea (Goodenough I.). Only known from type collection.

Ecol. High on trees in oak forest, at 1600 m.

30. *Elaphoglossum stenolepis* BELL ex HOLTUM, Blumea 14 (1966) 325. — *E. decurrens* (non DESV.) C. CHR. Gard. Bull. S. S. 7 (1934) 290, p.p. — Type: CLEMENS 28019, Mt Kinabalu (US).

*Rhizome* thick, short; scales c. 10 mm long, less than 1 mm wide, crisped, red-brown, entire, narrowed to a slender tip; phyllopodia c. 1 cm long. *Sterile frond*: stipe 7 cm long, the upper 2 cm narrowly winged; lamina 17–20 by  $3\frac{1}{2}$ –4 cm, rigid, rather thick, drying brown and wrinkled, widest above middle, narrowed gradually to wing at base and to broadly pointed or slightly rounded apex; thin pale edge very narrow; veins obscure; costa beneath broad, pale, little prominent; scales very small, stellate with 3–6 arms of several cells with small glandular cells laterally on arms. *Fertile frond*: stipe 11 cm; lamina 11 by 2.2 cm, rather abruptly narrowed at base and at rounded apex.

Distr. *Malesia*: N. Borneo (Mt Kinabalu), several collections.

Ecol. Epiphyte at 1500–2150 m.

Note. This species grows with *E. annamense*, and CLEMENS 27060 is a mixture of the two species. The scales of *E. stenolepis* are very distinctive, also the longer stipe.

31. *Elaphoglossum amblyphyllum* BELL, *nom. nov.* — *E. obtusifolium* BELL, Kew Bull. 14 (1960) 83, non BRACK. — *Acrostichum decurrens* (non DESV.) BL. En. Pl. Jav. (1828) 102; Fl. Jav. Fil. (1829) 32, t. 10; RACIB. Fl. Btzg 1 (1898) 47. — *E. decurrens* (non DESV.) v.A.v.R. Handb. (1908) 713, p.p.; Suppl. (1917) 424, p.p.; BACKER & POSTH. Varenfl. Java (1939) 249; HOLTUM, Rev. Fl. Mal. 2 (1954) 458, f. 268. — Type: BLUME, Java (L).

*Acrostichum obtusifolium* (non WILLD.) BL. En. Pl. Jav. (1828) 102; Fl. Jav. Fil. (1829) 31; HOOK. Spec. Fil. 5 (1864) 204, p.p. — *Olfersia blumeana* PRESL, Tent. Pterid. (1836) 235. — Type: BLUME, Java (L). — Fig. 19.

*Rhizome* short; scales pale brown, 10–12 mm long, to 2 mm wide at base, acuminate, edges  $\pm$  ciliate; phyllopodia 1 cm long. *Sterile frond*: stipe 7–15 cm long; lamina coriaceous, to 29 by  $8\frac{1}{2}$  cm, widest above the middle, apex broadly rounded, base cuneate and shortly decurrent; pale edge distinct, narrow; veins obscure; costa beneath broad and little prominent; scales small, appressed, stellate, with some small spherical cells near point of attachment. *Fertile frond*: stipe 20 cm; lamina to 20 by 4 cm.

Distr. *Malesia*: Sumatra, Malay Peninsula, Java, Borneo, Moluccas (Ambon).

Ecol. Epiphyte on old mangrove trees and by rivers, at 0–800 m.

Notes. The type is the specimen illustrated by BLUME as *Acrostichum decurrens*. As shown by BELL (*l.c.* 1960) it is certainly different from the type of *A. decurrens* DESV. The latter is a poor specimen, and I have been unable to identify any Malesian species with it. The specimen named *Acrostichum obtusifolium* WILLD. by BLUME is certainly not conspecific with WILLDENOW's type, which is probably a young plant of *Polypodium scolopendria* BURM. f. (photograph seen, showing venation). The name *Elaphoglossum obtusifolium* was published by BRACKENRIDGE with a description of a Fiji specimen, and citation of *Acrostichum obtusifolium* BL. (non WILLD.) as a synonym. RACIBORSKI's

description of *Acrostichum decurrens* was based on a specimen from Ambon (leg. TEYSMANN) which I have seen.

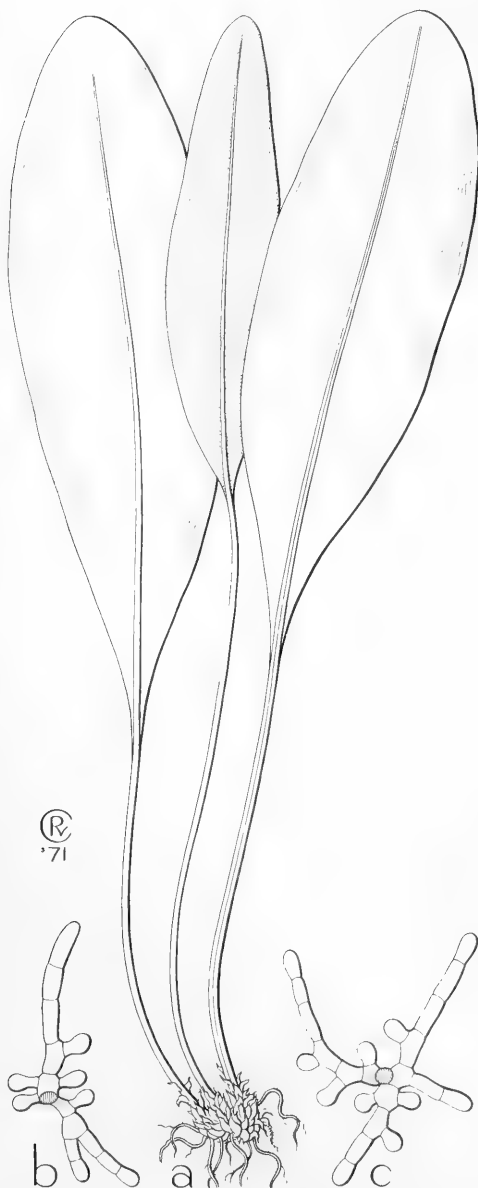


Fig. 19. *Elaphoglossum amblyphyllum* BELL. a. Habit, 1 fertile and 2 sterile fronds,  $\times \frac{1}{2}$ , b-c. scales from surface of frond,  $\times 75$  (L 908.332-621, 908.352-637).

32. *Elaphoglossum luzonicum* COPEL. in Elmer, Leaf. Philip. Bot. 1 (1907) 235; *ibid.* 2 (1908) 416; v.A.v.R. Handb. (1908) 714; COPEL. Fern Fl. Philip. (1960) 278. — Type: ELMER 9036 (MICH, teste COPEL. MS; dupl. in BO, K, L, P, US).

*Acrostichum decurrens* var. *ornatum* FÉE, Hist. Acrost. (1845) 34. — *Acrostichum decurrens* (non DESV.) Hook. Spec. Fil. 5 (1864) 203. — Type: CUMING 144, Luzon (BM, K, L, MICH, P, US).

*Acrostichum cumingii* (non FÉE) BAKER, Syn. Fil. (1868) 407. — *Acrostichum decurrens* var. *major* METT. ex KUHN, Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 292. — *E. decurrens* var. *cumingii* v.A.v.R. Handb. (1908) 713. — Type: CUMING 193, Luzon (BM, K, P).

*E. elmeri* COPEL. in Elmer, Leaf. Philip. Bot. 3 (1910) 849; v.A.v.R. Handb. Suppl. (1917) 424; COPEL. Fern Fl. Philip. (1960) 279. — Type: ELMER 11658, Mindanao (not seen).

*E. lepidopodium* C.CHR. ex OGATA, J. Jap. Bot. 13 (1937) 121. — Type: M. OGATA 60, Taiwan, Prov. Taito (BM).

*E. cumingii* var. *papuanum* C.CHR. Brittonia 2 (1937) 317. — Type: BRASS 4112, Papua (NY). — Fig. 20a-c.

*Rhizome* short; scales thin, light brown, 5-7 by 2-3 mm, edges with short hairs; phyllopodia to 2 cm long. *Sterile frond*: on young plants widest above middle with  $\pm$  broadly rounded apex and gradually narrowed base, with a rather persistent fringe of spreading scales  $1\frac{1}{2}$ -2 mm long all along edge of lamina; lamina to c. 20 by 4 cm; on mature plants with stipe 10-15 cm, persistently scaly as rhizome, lamina rigidly coriaceous, to 25 by 3.2-4 $\frac{1}{2}$  cm, widest at or a little above middle, sides parallel for most of their length, narrowed rather abruptly at both ends, base a little decurrent, apex bluntly pointed or rounded; pale thin edge distinct; veins obscure; costa slightly raised on lower surface; small scales on lamina light brown, to 1 mm long, narrow with hairs near base, near edge of lamina on both surfaces broader scales 1 mm long  $\pm$  persistent. *Fertile frond*: stipe 17 cm; lamina to 26 by 3 $\frac{1}{2}$  cm.

Distr. Taiwan; in *Malesia*: Philippines (Luzon, Negros, Panay, Mindanao), E. New Guinea.

Ecol. In mossy forest, at 2000-2300 m (few altitudes recorded).

Notes. The type of *E. luzonicum* cited with the original description was ELMER 8190; but COPELAND wrote "Type" on the specimen of no 9036 in his own herbarium (MICH) without explaining the discrepancy. I have not seen any specimen bearing the number ELMER 8190.

The treatment of this species (and, with it, that of *E. amblyphyllum*) has been very confused, both taxonomically and nomenclaturally. In his enumeration of CUMING's Philippine ferns, JOHN SMITH cited CUMING 144 and 193 under the name *E. obtusifolium*, based on *Acrostichum obtusifolium* WILDL. citing *A. decurrens* BL. as synonym. But as the generic name *Elaphoglossum* had not then been validly published, the binomial *E. obtusifolium* J.SM. was illegitimate (see p. 314). Further, the type of *Acrostichum obtusifolium* WILDL. is a *Polypodium*-ally; and the specimen described by BLUME as *A. decurrens* does correspond with DESVAUX's type of that species; both epithets will also be found confusedly in the synonymy of *E. amblyphyllum*.

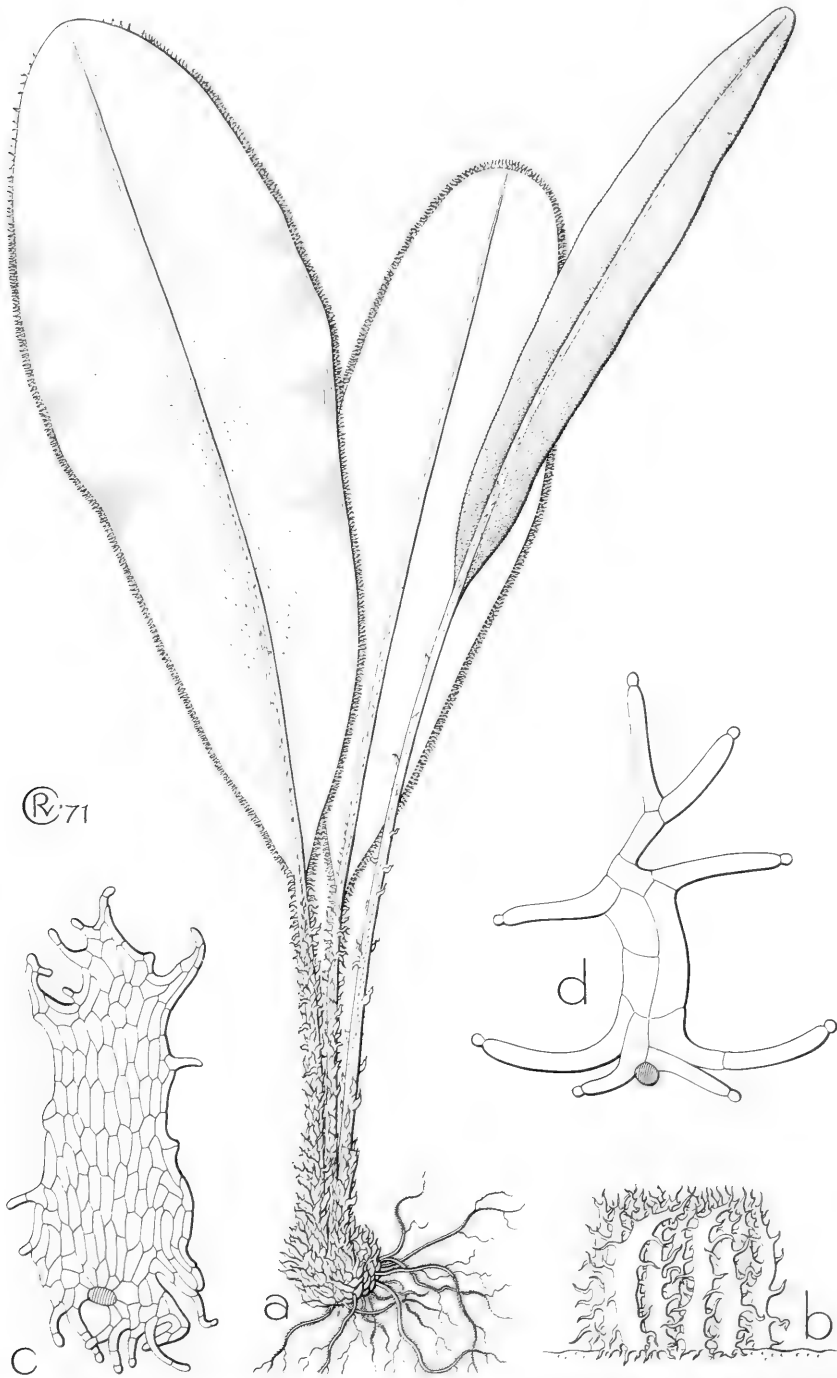


Fig. 20. *Elaphoglossum luzonicum* COPEL. a. Habit,  $\times \frac{1}{2}$ , b. scales on margin of frond,  $\times 10$ , c. scale from margin,  $\times 25$ . — *E. apoense* HOLTUM. d. Scale from surface of frond,  $\times 75$  (a-b BS 35595 & a part of ELMER 17489, d EDaño PNH 710).

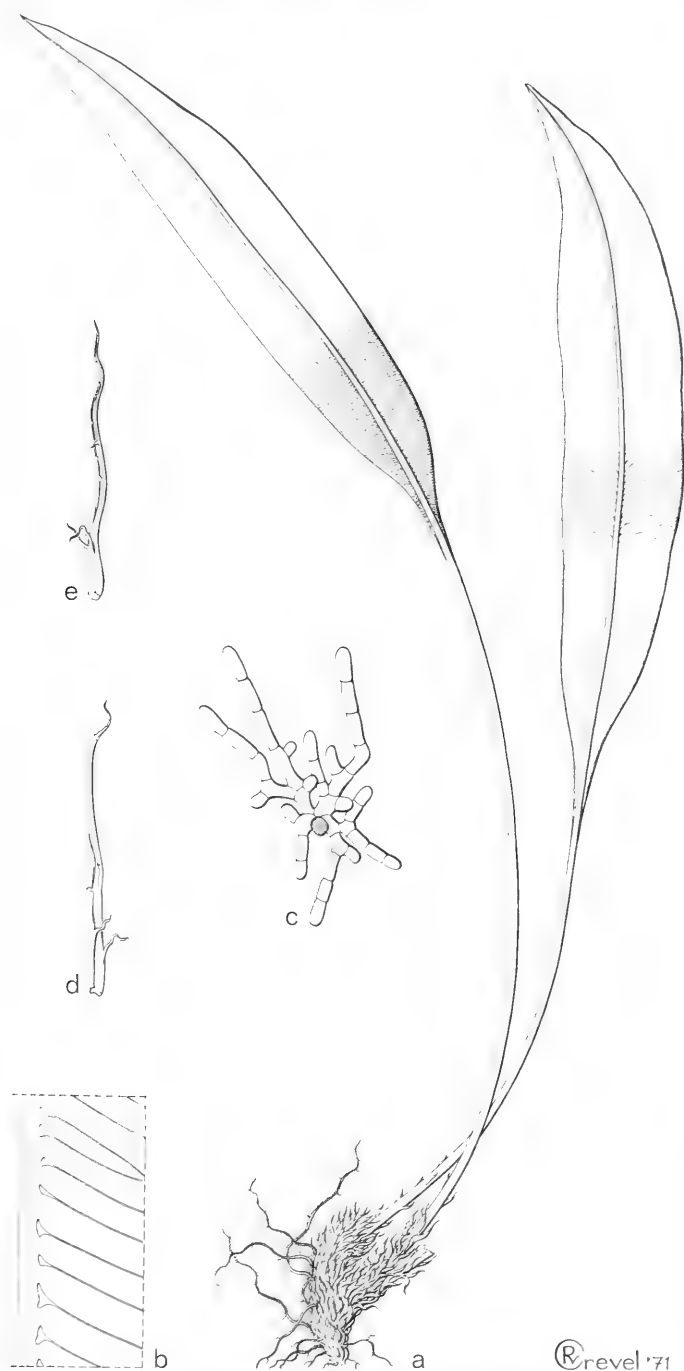


Fig. 21. *Elaphoglossum callifolium* (BL.) MOORE. a. Habit, 1 sterile and 1 fertile frond,  $\times \frac{1}{3}$ , b. margin of sterile frond,  $\times 3$ , c. scale from surface of frond,  $\times 50$ , d-e. scales from base of stipe,  $\times 2$  (a-b, d L 908.331-933).

FÉE described his specimen of CUMING 144 as *Acrostichum decurrens* var. *ornatum*. He cited CUMING 193 as type of *A. cumingii*, but, as noted by COPELAND, his description does not agree with specimens of that collection in other herbaria, and his name is therefore here regarded as doubtful (see p. 314). HOOKER included *A. cumingii* FÉE as one of many synonyms of *A. conforme* Sw. (Spec. Fil. 5: 199) citing CUMING 193; but BAKER, in Syn. Fil., recognized *A. cumingii* as a distinct species, basing his description on the specimen of CUMING 193 in HOOKER's herbarium.

In 1960 COPELAND doubted whether his *E. elmeri* and *E. luzonicum* were distinct species. I have examined many specimens of the type collection of *E. luzonicum* and of CUMING 144 and 193. I have come to the conclusion that the type of *E. luzonicum* and CUMING 193 are conspecific. CUMING 144 consists entirely of sterile plants, and I regard these as  $\pm$  immature stages of the same species as 193; some other collections show intermediate conditions. As in some other species of this genus, young plants have fronds with more broadly rounded apices and more decurrent bases than fronds of mature plants. Fronds of young plants also have a more persistent fringe of scales which are larger than on mature plants; old fronds of some mature plants lack such a fringe, but the scars of attachment of the scales can be seen.

**33. *Elaphoglossum brevifolium* HOLTUM**, Gard. Bull. Sing. 11 (1947) 270; Rev. Fl. Mal. 2 (1954) 458, f. 267. — Type: HOLTUM 20750, G. Tahan, Malaya (SING; dupl. in K).

*Rhizome* short; scales rather light brown, thin, c. 10 by  $1\frac{1}{2}$  mm, tapered to a slender apex, entire; phyllopodia 1 cm long. *Sterile frond*: stipe 4–12 cm long, pale, about half of it with a very narrow wing, bearing some residual scales as rhizome; lamina thick and rigid when dry, 8–12 by  $3\frac{1}{2}$ –6 cm, almost elliptical but base decurrent, apex broadly bluntly pointed; thin pale edge  $\frac{1}{2}$  mm wide, sometimes deflexed on drying; veins obscure; costa beneath slightly prominent in basal half; scales on surfaces at first abundant, very small, with a few marginal hairs of 2–3 cells. *Fertile frond*: stipe 20–25 cm; lamina 8–10 by 2–3 cm, shape as sterile.

*Distr. Malesia*: Malay Peninsula (G. Tahan and G. Batu Puteh).

*Ecol.* 1400–1850 m; on G. Tahan a low epiphyte in mossy forest.

**34. *Elaphoglossum negrosensis* HOLTUM**, Blumea 14 (1966) 323. — *E. conforme* [non (SW.) J.S.M.] COPEL. in Elmer, Leaf. Philip. Bot. 2 (1908) 417. — *E. angulatum* [non (BL.) MOORE] COPEL. Fern Fl. Philip. (1960) 278, p.p. — Type: ELMER 9885, Philippines, Negros (MICH; BO).

*Rhizome* short; scales rather light brown, to 7 by  $2\frac{1}{2}$  mm, acuminate but not hair-pointed, with few marginal hairs; phyllopodia 1 cm long. *Sterile frond*: stipe 2–8 cm, scaly when young as rhizome; lamina thinly coriaceous, 11–17 by 2.7–3.3 cm, widest at or below middle, apex evenly narrowed to a very narrowly rounded tip, hardly acuminate, base rather abruptly narrowed and then decurrent as a wing 2 cm long on the stipe; thin pale edge distinct, less than  $\frac{1}{2}$  mm wide; veins slender, distinct on both surfaces, rather widely spaced,

their apices thickened and not joining; costa hardly prominent on lower surface; no scales seen on lamina. *Fertile frond*: stipe 10–12 cm; lamina 8–11 by 1.3–1 $\frac{1}{2}$  cm, shape as sterile.

*Distr. Malesia*: Philippines (Negros Oriental). Only known from type collection.

*Ecol.* In forest, at 1400 m.

*Note.* The type was originally named *E. conforme* by COPELAND, and later re-named *E. angulatum*, from which it differs in rhizome and vein characters.

**35. *Elaphoglossum planicosta* HOLTUM**, Blumea 14 (1966) 324. — Type: JERMY 4216, NE. New Guinea, Madang Distr., Finisterre Mts (BM).

*Rhizome* short; scales 10 by  $2\frac{1}{2}$  mm, narrowed evenly to apex, light brown, thin, with slender marginal hairs; phyllopodia to 1 cm long. *Sterile frond*: stipe pale or slightly rufous, 6–9 (–13) cm long, upper 2–3 cm with narrow wing decurrent from lamina; lamina thick and rigid when dry, 11–15 by 2.7–3.4 cm, widest about middle, rather abruptly narrowed to a  $\pm$  obtuse-angled apex and more gradually to a narrowly cuneate base; thin pale edge more than  $\frac{1}{2}$  mm wide; veins obscure except on young fronds, their apices thickened, sometimes forked, the branches then sometimes meeting those of adjacent veins; costa broad, pale, almost flat on lower surface; scales on both surfaces of young fronds appressed, stellate, mostly c.  $\frac{1}{2}$  mm  $\varnothing$  including arms. *Fertile frond*: stipe 15 cm; lamina 11 by 3 cm, shape as sterile.

*Distr. Malesia*: NE. New Guinea (two collections).

*Ecol.* In degenerate cloud-forest, epiphytic, at 2750 m.

*Note.* A fixation from the type collection gave a chromosome count  $n = c. 82$  (tetraploid).

**36. *Elaphoglossum callifolium* (BL.) MOORE**, Ind. Fil. (1857) 7; CHRIST, Monogr. Elaph. (1890) 34; v.A.v.R. Handb. (1908) 714; Suppl. (1917) 425; C. CHR. Gard. Bull. S. S. 7 (1934) 289; BACKER & POSTH. Varenfl. Java (1939) 251; HOLTUM, Rev. Fl. Mal. 2 (1954) 459, p.p.; COPEL. Fern Fl. Philip. (1960) 277. — *Acrostichum callifolium* BL. En. Pl. Jav. (1828) 100; Fl. Jav. Fil. (1829) 22, t. 4; FÉE, Hist. Acrost. (1845) 28; RACIB. Fl. Btzig 1 (1898) 47. — *Olfersia callifolia* PRESL, Tent. Pterid. (1836) 234. — Type: BLUME, Java (L).

*Acrostichum junghuhnianum* KUNZE, Bot. Zeit. 6 (1848) 101. — *E. junghuhnianum* MOORE, Ind. Fil. (1857) 10. — Type: JUNGHUHN, Mt Lawu (not seen).

*E. reineckei* HIERON. & LAUTERB. Bot. Jahrb. 41 (1908) 220. — Type: VAUPEL 452, Samoa (B).

*E. permutatum* var. *mutatum* v.A.v.R. Bull. Jard. Bot. Btzig II, 16 (1914) 13; Handb. Suppl. (1917) 426. — Type: RACHMAT 604, Mt Boesoe, Celebes (BO).

*E. macgregorii* COPEL. Philip. J. Sc. 11 (1916) Bot. 40; v.A.v.R. Handb. Suppl. (1917) 424. — Type: R. C. MCGREGOR BS 19780, Luzon (MICH).

*E. laurifolium* [non (THOUARS) MOORE] v.A.v.R. Handb. (1908) 714, p.p.; BACKER & POSTH. Varenfl. Java (1939) 251, p.p.

*E. commutatum* [non (METT.) v.A.v.R.] v.A.v.R. Handb. Suppl. (1917) 427, p.p. — Fig. 21, 26f.



*Rhizome* massive, fronds close; scales c. 10 by 1 mm, rather stiff and straight, often with inflexed edges but not crisped even near apex, entire or nearly so, dull brown; phyllopodia 2–3 cm long. *Sterile frond*: stipe 10–18 cm, rather thick, grooved deeply on upper surface only; lamina coriaceous, commonly to 35 by 5–6 cm, to 48 by 8 cm or more (80 by 10 cm reported in Java), acuminate, base rather narrowly cuneate and a little decurrent; thin edge pale, narrow, usually reflexed when dry; veins distinct but little prominent; costa rounded and prominent beneath; scales on lamina scattered, very small, stellate, brown. *Fertile frond*: stipe usually longer than sterile, to 20 cm or more; lamina commonly to 25 by 4 cm, base rather abruptly narrowed, apex short-acuminate.

Distr. S. Vietnam, throughout *Malesia*; eastwards to Samoa.

Ecol. In mountain forest, sometimes in a dense growth of other epiphytes, at 1000–2400 m.

Notes. There are a few quite small, but fertile, specimens from Java, Sumatra and Borneo which agree so closely with typical *E. callifolium* that I place them here. At least some such have been called *E. laurifolium* (the type of which, from Tristan d'Acunha, is very different in scales) and *E. commutatum*, which see for further comment. But I do not think that the specimen originally named *E. conforme* by BLUME belongs here (see *E. recommutatum*). The Malay Peninsula specimens here described as *E. malayense* have also been called *E. callifolium*, but are very distinct in their scales; I have seen only one Peninsula specimen which seems to be true *E. callifolium*, with a frond 50 by 9 cm.

37. *Elaphoglossum commutatum* (METT. ex KUHN) v.A.v.R. Handb. Suppl. (1917) 427; SLEDGE, Bull. Brit. Mus. (Nat. Hist.) 4 (1967) 90. — *Acrostichum commutatum* METT. ex KUHN, Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 292, excl. spec. Blum. — *Acrostichum laurifolium* (non THOUARS) THW. En. Pl. Zeyl. (1864) 380. — Type: THWAITES 1310 (B; dupl. in K).

*E. permutatum* v.A.v.R. Bull. Jard. Bot. Btzig II. 16 (1914) 13; Handb. Suppl. (1917) 425, excl. var. *mutatum*. — Type: MATTHEW 696, Mt Sago, Sumatra (BO). — Fig. 16a.

*Rhizome* usually short with close fronds; scales to 10 by 1½ mm, medium brown, rather thin, ± crisped throughout but especially towards hair-pointed apices which are often tangled, edges with some spreading hairs; phyllopodia 1–1½ cm long. *Sterile frond*: stipe rather slender, 5–15 cm long, rather deeply 3-sulcate almost to base; lamina thinly coriaceous, commonly to 25 by 6 cm, exceptionally to 30 by 9 cm, distinctly elliptic, rather shortly acuminate, cuneate and slightly decurrent at base; thin edge very narrow, often deflexed; veins slender, prominent on both surfaces, not joining at tips; costa prominent on both surfaces, rather deeply grooved on upper; scales brown, stellate, mostly under ½ mm in total Ø. *Fertile frond*: stipe sometimes longer than sterile; lamina 12–17 by 1.8–2½ cm.

Distr. Ceylon & S. India; in *Malesia*: Sumatra, W. Java, Borneo, New Guinea.

Ecol. In forest, in two cases recorded as terrestrial (MATTHEW reported of the type of *E. permu-*

*tatum* “in a patch of moist ground in forest”), at 900–1700 m.

Notes. THWAITES 1310 from Ceylon is taken as type, as it is apparent that KUHN's description was made chiefly from it. The BLUME specimen cited is not a good one and the scales are mostly broken; in my opinion it represents a distinct species (*E. recommutatum*).

Below the decurrent base of the lamina of a frond, a distinct groove develops on each side of the median groove; these lateral grooves are on the lines of the decurrent edges of the lamina (v.A.v.R. described the stipe of *E. permutatum* as plurisulcate).

I have wondered whether *E. commutatum* could be an ecologic form of *E. callifolium*, growing in unusually moist shady conditions. But the Malesian specimens here described agree so closely (except that fronds are somewhat larger) with those from Ceylon and S. India, where typical *E. callifolium* is lacking, that I think it right to maintain *E. commutatum* as a distinct species. MATTHEW, who knew *E. callifolium* well in the field, wrote a MS note on his Sumatran specimen of *E. permutatum* “a most distinct species, fully 500 feet below the level of *E. callifolium*”.

38. *Elaphoglossum malayense* HOLTUM, Blumea 14 (1966) 322. — *E. callifolium* (non BL.) HOLTUM, Rev. Fl. Mal. 2 (1954) 459, p.p. max. — Type: HENDERSON 17765, Cameron Highlands, Malaya (K; dupl. in SING).

*Rhizome* short, thick, scales to 25 by 3 mm, rather light red-brown, flat, firm, acuminate, marginal hairs rare; phyllopodia to 1½ cm long. *Sterile frond*: stipe on immature plants short, on mature plants 5–10 cm; lamina rather thinly coriaceous, to 40 by 5 cm, apex rather shortly acuminate, narrowed more gradually to base and then decurrent as a narrow wing 5 cm or more long; thin edge very narrow, reflexed; veins distinct at least on upper surface, hardly prominent; costa prominent on both surfaces; superficial scales not persistent, very small, stellate. *Fertile frond*: stipe 8–15 cm; lamina to 24 by 2.2 cm, base decurrent or not.

Distr. *Malesia*: Malay Peninsula, Borneo.

Ecol. Epiphyte, at 1050–1400 m.

Notes. This species has been called *E. callifolium* but differs strikingly from the typical *E. callifolium* of Java in its much larger flat rhizome-scales and proportionately narrower, more rigid fronds. Fronds on smallish plants mostly have rather short stipes and much-decurrent lamina, and such plants may bear fertile fronds. In the type collection one specimen has a fertile frond with stipe 8 cm and lamina 18 by 2 cm, base narrowly decurrent, the other has stipe 15 cm, lamina 24 by 2.2 cm, base rather abruptly narrowed. The latter also has costa deeply grooved on upper surface and very prominent below, the former has costa shallowly grooved above and not very prominent beneath.

39. *Elaphoglossum recommutatum* HOLTUM, nom. nov. — *Acrostichum conforme* (non SW.) BL. Fl. Jav. Fil. (1829) 23, t. 5. — *Acrostichum aemulum* (non KAULF.) BL. En. Pl. Jav. (1828) 101. — Type: BLUME, Java (L; dupl. in P).



*Rhizome* short; scales *c.* 6 by  $2\frac{1}{2}$  mm, not long-acuminate, dull medium brown; phyllopodia 1 cm long. *Sterile frond*: stipe 2 cm (type) to 10 cm long; lamina of type 15 by  $2\frac{1}{2}$  cm, of other specimens to 27 by  $4\frac{1}{2}$  cm, thinly coriaceous, base cuneate and slightly decurrent, apex shortly acuminate; pale edge narrow, deflexed; veins just distinct; costa somewhat prominent beneath; scales small, stellate, appressed. *Fertile frond*: stipe of type 5 cm, of other specimens to 22 cm; lamina of type 12 by 1.8 cm, of another Java specimen 28 by 2.2 cm, of a Celebes specimen 20 by  $3\frac{1}{2}$  cm.

Distr. *Malesia*: Sumatra, Java, SW. Celebes.

Notes. KUHN cited BLUME's specimen under *Acrostichum commutatum* METT., but he evidently described the scales of *A. commutatum* from the Ceylon specimen of THWAITES, as *longe acuminatis*, adding parenthetically (*apice denique delapsis*) an apparent reference to the BLUME specimen, the scales of which are mostly broken. But I judge from BLUME's drawings of the scales, and from another Java specimen (LOBB *s.n.*, K) that the scales are very different from those of the THWAITES specimen; see further comment under *E. commutatum*.

*E. recommutatum* appears to be the Malesian species nearest to *E. conforme* (Sw.) MOORE, type species of the genus. It differs from typical *E. conforme* in the short-acuminate frond-apices and in lacking the resin-spots which occur abundantly on the lower surface of that species.

40. *Elaphoglossum sordidum* CHRIST, Nova Guinea 8 (1909) 156; v.A.v.R. Handb. Suppl. (1917) 425; COPEL. Philip. J. Sc. 78 (1949) 404. — Type: VERSTEEG 1432, W. New Guinea (BO). — Fig. 22.

*Rhizome* short; scales medium brown, thin, to 6 by 2 mm, acuminate, with many spreading marginal hairs; phyllopodia 1 cm long. *Sterile fronds*: stipe pale, 10–12 cm long, rather persistently scaly, scales narrow; lamina thinly coriaceous, 20–30 by  $3\frac{1}{2}$ – $4\frac{1}{2}$  cm, narrowly elliptical, base gradually long-decurrent, apex more shortly acuminate; thin pale edge narrow, deflexed; veins distinct, slightly prominent; costa prominent, slender and terete on lower surface; scales on lower surface appressed, narrow, to 1 mm long, with long marginal hairs. *Fertile fronds*: stipe 12–18 cm; lamina 13–25 by 1–3 cm.

Distr. *Malesia*: W. New Guinea (4 collections).

Ecol. Epiphyte, at 250–780 m.

41. *Elaphoglossum novoguineense* ROSENST. in Fedde, Rep. 10 (1912) 341; v.A.v.R. Handb. Suppl. (1917) 423; COPEL. Philip. J. Sc. 78 (1949) 404. — Type: BAMLER S.67, NE. New Guinea, Sattelberg (not seen).

*E. brassii* C.CHR. Brittonia 2 (1937) 316. — Type: BRASS 5558, Mafulu, Papua (NY).

*Rhizome* short; scales rather thick, dull medium brown, *c.* 5–10 by  $2\frac{1}{2}$  mm, subentire or sparsely hairy, tapering evenly from base to acute apex; phyllopodia 1–1 $\frac{1}{2}$  cm long. *Sterile frond*: stipe 4–11 cm long; lamina thinly coriaceous, 20–33 by 2.8–4 cm, widest about middle, base gradually narrowed and decurrent for 2–3 cm, apex acute to acuminate; pale edge narrow, reflexed; veins often slightly prominent; costa rather broad and pale beneath, only slightly prominent; scales small,



Fig. 22. *Elaphoglossum sordidum* CHRIST. a. Habit, 2 sterile fronds, 1 fertile frond,  $\times \frac{1}{3}$ , b–c. scales from base of stipe,  $\times 3$  (a fertile, b BRASS 23000, a sterile, c BRASS 11498).

stellate. *Fertile frond*: stipe 10–16 cm; frond 15–20 by 1.2–2 cm.

*Distr. Malesia*: New Guinea.

*Ecol.* Epiphyte, at 1200–2400 m.

*Notes.* I have examined a KEYSER specimen (S-PA) from the type locality named and distributed by ROSENSTOCK. The type of *E. brassii* is smaller than above described, with sterile lamina 15 by 3 cm, fertile 7 by 1 cm, but agrees in scaliness. One specimen collected in NE. New Guinea by T. G. WALKER (8155) gave a chromosome count  $n = c. 82$  (tetraploid).

**42. *Elaphoglossum robinsonii* HOLTUM, sp. nov.**

*Paleis pallidis tenuibus integris stipitibusque longis frondium fertilium cum E. brevifolio HOLTUM (sp. 33) congruens, ab eo differt frondibus multo majoribus, fertilibus sterilibus aequilatis, sporisque multialatis.*

*Rhizome* short; scales to 15 by 2 mm, light brown, thin, flat, margins entire, tapering to apex but not hair-pointed; phyllopodia  $1\frac{1}{2}$  cm long. *Sterile frond*: stipe to 12 cm long, scaly when young; lamina to 28 by  $4\frac{1}{2}$  cm, widest at middle and gradually narrowed to both ends, apex broadly pointed (less than  $90^\circ$ ), base narrower and slightly decurrent; midrib slightly prominent on lower surface near base, distally almost flat, more prominent and grooved on upper surface; cartilaginous edge less than  $\frac{1}{2}$  mm wide, reflexed when dry, lacking scales; scales on lower surface of lamina stellate, to  $c. \frac{1}{2}$  mm diameter, with a few short rays. *Fertile frond*: stipe to 24 cm long; lamina to 25 by  $4\frac{1}{2}$  cm, sides almost parallel for much of their length, base rather broadly cuneate and slightly decurrent, apex broadly pointed; spores bearing numerous small translucent wings.

*Type*: H. C. ROBINSON, Jan. 1913, Gunong Mengkuang, Selangor, Malaya (K).

*Distr.* Only known from the type and A. G. PIGGOTT 1093, 1094, from the neighbouring mountain, G. Ulu Kali, at 1500–1800 m.

*Note.* This species differs from *E. malayense* HOLTUM, the common species on the Main Range in Malaya, in thinner paler scales, less decurrent base of sterile frond and longer stipe of fertile fronds.

**43. *Elaphoglossum favigerum* HOLTUM, Blumea 14 (1966) 321. — Type: BRASS 13440, W. New Guinea, near Idenburg River (GH; MICH).**

*Rhizome* short; scales dull dark brown, to  $c. 8$  by  $1\frac{3}{4}$  mm, rather thin, not acuminate, cells  $\pm$  hexagonal, isodiametric, edges with a few long hairs; phyllopodia  $c. 1\frac{1}{2}$  cm long. *Sterile frond*: stipe 10–16 cm; lamina thinly coriaceous, to 39 by  $4\frac{1}{2}$  cm, widest at middle or below it, base cuneate and slightly decurrent, apex gradually narrowed, acute; thin edge narrow, reflexed, hardly de-coloured; veins distinct on upper surface; costa beneath prominent; scales on lower surface minute, slightly stellate or not. *Fertile frond*: stipe 14–16 cm; lamina to 22 by  $2\frac{1}{2}$  cm, base rather abruptly narrowed, more gradually to acute apex.

*Distr. Malesia*: W. New Guinea (3 collections).

*Ecol.* Occasional low epiphyte, 1200–1500 m.

**44. *Elaphoglossum sumatranum* HOLTUM, Blumea 14 (1966) 325. — Type: MATTHEW s.n., 21 Jan. 1913, Sumatra, G. Tandikat (K).**

*Rhizome* short; scales pale brown, rather thin, to 10 by  $2\frac{1}{2}$  mm, tapering to apex, subentire; phyllopodia 1 cm long. *Sterile frond*: stipe 5–8 cm, pale, bearing scales as rhizome but smaller; lamina 20–30 by  $3\frac{1}{2}$ –5 cm, thick, rigid, drying green, widest at or a little above middle, base gradually or rather abruptly narrowed and slightly decurrent, distally narrowed rather abruptly to rounded apex; edge thick and pale; veins obscure; costa pale, slightly prominent beneath; scales on lower surface small, stellate. *Fertile frond*: stipe 15–20 cm; lamina 14–17 by 1.8–3.3 cm; spores 52–59 by 33–37  $\mu$ m, with broad perispore having very few folds in it.

*Distr. Malesia*: Central Sumatra (two collections).

*Ecol.* Epiphyte, at 1500 m.

**45. *Elaphoglossum indrapuræ* HOLTUM, Blumea 14 (1966) 321. — Type: ALSTON 14275, Central Sumatra, near G. Kerintji, Sg. Tandok, Kayu Aro Estate (BM).**

Similar to *E. sumatranum* in rhizome-scales and spores, but with thinner, much longer fronds. *Sterile frond*: stipe 14–18 cm; lamina 35–55 by 3–5 cm, thinly coriaceous, base cuneate and slightly decurrent, gradually narrowed distally to narrowly rounded apex; pale edge thin, narrow, deflexed; veins distinct and slightly prominent on upper surface. *Fertile frond*: stipe 38 cm; lamina 33 by 3 cm, base decurrent to a narrow wing 3 cm long.

*Distr. Malesia*: Central West Sumatra. Only known from type collection.

*Ecol.* In forest, at 1500 m.

*Note.* This is closely related to *E. sumatranum*, and was collected in the same region, but is so much larger that I think it should stand as a distinct species. It should be noted that ALSTON also collected typical *E. sumatranum*, and no intermediates between the two have been found.

**46. *Elaphoglossum spongophyllum* BELL ex HOLTUM, Blumea 14 (1966) 325. — Type: CLEMENS 31869, N. Borneo, Mt Kinabalu, Upper Kinataki R. (BO).**

*Rhizome* short; scales to 15 by  $2\frac{1}{2}$  mm, acuminate, rather thin, flat, pale when young, later red-brown, edges with a few hairs; phyllopodia  $1\frac{1}{2}$ –2 cm long. *Sterile frond*: stipe 8–15 cm long, pale; lamina thick, rigid, light brown when dry, to 33 by 7 cm, widest at or above middle, base rather narrowly cuneate, little decurrent, towards apex  $\pm$  abruptly narrowed to a rounded tip; pale edge thin, very narrow; veins obscure; costa beneath broad, pale, little prominent; scales on lower surface with very small dark centre and 2–4 slender radiating arms. *Fertile frond*: stipe 15 cm; lamina 20–25 by  $3\frac{1}{2}$ –4 cm, widest above middle, base rather narrowly cuneate, apex abruptly narrowed to a narrowly rounded tip; spores  $c. 37 \mu$ m long, with much-folded perispore.

*Distr. Hainan*; in *Malesia*: Malay Peninsula, N. Borneo (Mt Kinabalu).

*Ecol.* Epiphyte, at 2150–2920 m in N. Borneo, 1550–1850 m in Malaya.

*Notes.* The only Malayan specimen is from G. Tahan. The Hainan specimen (MCCLEURE 20066) was distributed as *E. austrosinicum* MATT. & CHR., which has acuminate fronds much more

decurent at the base. *E. spongophyllum* has somewhat the same shape of frond as *E. sumatranum*, but it always dries brownish, and the spores are very different.

**47. *Elaphoglossum blumeum*** (FÉE) J.S.M. Ferns Brit. & For. (1866) 106. — *Acrostichum blumeum* FÉE, Hist. Acrost. (1845) 62, excl. syn. *Olfersia blumeana* PRESL. — Type: CUMING 194, Luzon (P; dupl. in US).

*E. copelandii* CHRIST, Philip. J. Sc. 2 (1907) Bot. 176; v.A.v.R. Handb. (1908) 717; COPEL. Fern Fl. Philip. (1960) 277. — Type: COPELAND 1541, Mindanao (P; dupl. in B, US).

*Acrostichum viscosum* (non Sw.) BL. Fl. Jav. Fil. (1829) 27; RACIB. Fl. Btzig I (1898) 46.

*E. petiolatum* [non (Sw.) URB.] v.A.v.R. Handb. (1908) 717; Suppl. (1917) Corr. 29; BACKER & POSTH. Varenfl. Java (1939) 250.

*E. yunnanense* [non (BAKER) C.CHR.] HOLTUM, Rev. Fl. Mal. 2 (1954) 455, f. 264. — Fig. 23a-f.

**var. *blumeum*.**

*Rhizome* creeping, 3–5 mm Ø when dry, bearing fronds close together or to 1 cm apart in each of two ranks; scales c. 5 mm long, 1/2 mm wide, dark brown, glossy, rigid, acuminate, ± contorted with inrolled edges which bear a few teeth or stiff hairs; phyllopodia to 8 mm long. *Sterile frond*: stipe 12–30 cm long, near base with dark spreading scales as rhizome but often with numerous stiff marginal hairs, rest of stipe ± persistently covered with small stellate scales; lamina to 50 by 3 1/2 cm, rather thin, base rather narrowly cuneate, apex acuminate; thin pale edge very narrow; veins slightly prominent on lower surface; costa beneath rounded, prominent; scales on upper surface soon abraded, thin, pale, appressed, ± circular with rather long slender marginal hairs appressed to surface; scales on lower surface rather persistent, very small but with 3–5 stiff marginal hairs to almost 1 mm long spreading away from surface, on old fronds often abraded but leaving resin-dots at points of attachment. *Fertile frond*: stipe 20–35 cm; lamina to 30 by 1.4 cm.

*Distr. Malesia*: Sumatra, Malaya, Java, Borneo, Celebes, Philippines.

*Ecol.* Epiphyte at 700–2000 m, fronds pendulous.

**var. *philippinense*** CHRIST MS, *var. nov.* — Type: ELMER 6509, Baguio, Luzon (P; dupl. in B, MICH).

*Cum varietate typica squamulis rhizomatis frondisque congruente, differt: frondibus multo minoribus; stipite frondis sterilis 4–6 cm longo, lamina ad 15 × 1.5 cm; stipite frondis fertilis 10–18 cm longo, lamina 5–12 cm × 6–8 mm.*

*Distr. Malesia*: Philippines (Luzon). Several collections.

**Notes.** The name *E. blumeum* was published by JOHN SMITH in his list of CUMING's Philippine ferns, with a reference to *Acrostichum viscosum* BL. non Sw.; but as the generic name *Elaphoglossum* had not then been validly published JOHN SMITH's new name was illegitimate. FÉE was the next author to publish the epithet *blumeum* for this species; he referred to J. SMITH (the illegitimate publication of 1841) but not to BLUME, and

described and cited CUMING 194 only, for which reason the CUMING specimen must be the type of *Acrostichum blumeum* FÉE.

This species is nearly allied to *E. petiolatum* (Sw.) URB. of the West Indies. There are also closely allied forms in Africa and the Mascarene Is. (*E. salicifolium* (WILLD. ex KAULF.) ALSTON) and India (*Acrostichum stelligerum* WALL. ex BAKER), and it would be possible to regard all as varieties of one species. *E. blumeum* is however larger than the others, and appears to have a greater difference between scales of the upper and lower surfaces, the latter being especially distinctive. The name *E. yunnanense* (BAKER) C.CHR. is probably to be regarded as synonymous with *Acrostichum stelligerum*; the latter epithet has priority but has not yet been formally transferred to *Elaphoglossum*.

**48. *Elaphoglossum miniatum*** (CHRIST) CHRIST, Monogr. Elaph. (1899) 72, f. 30; v.A.v.R. Handb. (1908) 716. — *Acrostichum miniatum* CHRIST, Verh. Nat. Ges. Basel 11 (1895) 254, t. 3, f. 25–27; Ann. Jard. Bot. Btzig 15 (1898) 175. — Type: SARASIN 954, Central Celebes (BAS). — Fig. 23g-j.

*Rhizome* and scales as *E. blumeum*. *Sterile frond*: stipe 7 cm or more, bearing spreading scales 2–3 mm long, paler than on rhizome and with many stiff marginal hairs, also many appressed orbicular ciliate scales; lamina to 25 by 2 1/2 cm or more, shape as *E. blumeum*; scales on upper surface very pale, flat, appressed, ± circular with fringe of pale hairs shorter than width of scale, close to edge of upper surface a fringe of similar but elongate scales (1 mm long) spreading at right angles to edge of lamina and beyond it; scales on lower surface red-brown, a little smaller than those on upper surface, with inflexed edges bearing thicker much longer stiff hairs (to 1 1/2 mm long). *Fertile frond*: stipe 15 cm or more; lamina to 30 cm long, hardly 1 cm wide.

*Distr. Malesia*: Celebes (two collections); New Guinea (?).

*Ecol.* At c. 1000 m altitude.

**Note.** Some New Guinea specimens seem somewhat intermediate between this species and *E. heterolepium* as regards scales on the lower surface, but the types of the two species (both from Celebes) are very distinct.

**49. *Elaphoglossum heterolepium*** v.A.v.R. Bull. Jard. Bot. Btzig II, 16 (1914) 13; Handb. Suppl. (1917) 426. — *E. petiolatum* (Sw.) URBAN, var., C.CHR. Gard. Bull. S. S. 7 (1934) 291. — Type: RACHMAT 522, partim, Central Celebes (BO). — Fig. 23k-m, 24.

*Rhizome* and scales as *E. blumeum*. *Sterile frond*: stipe to 20 cm or more long; lamina light green when fresh, drying dark, thin, 25–45 by 2–2.7 cm, apex acuminate, base more abruptly narrowed and slightly decurrent; thin edge narrow, reflexed; veins distinct; costa rounded and prominent beneath, bearing some dark appressed scales; scales on upper surface pale, thin, flat, circular, short-ciliate, those near edge of lamina sometimes spreading a little beyond the edge; scales on lower surface often (always?) peltate, similar in shape to those of upper surface but firmer and more persistent, when dry with edges turned away from lamina-surface, thus ± cup-shaped. *Fertile frond*:



Fig. 23. *Elaphoglossum blumeanum* (FÉE) J. SM. a. Habit,  $\times \frac{1}{3}$ , b-c. scales of upper surface of frond,  $\times 20$ , d. scales of lower surface,  $\times 20$ , e. scale from stipe,  $\times 7$ , f. edge of sterile frond. — *E. miniatum* (CHRIST) CHRIST. g. Scale from upper surface of frond,  $\times 20$ , h. marginal cells of g,  $\times 65$ , i. scale from edge of upper surface,  $\times 20$ , j. scale from lower surface,  $\times 20$ . — *E. heterolepium* v.A.v.R. k. Habit,  $\times \frac{1}{3}$ , l. scale from upper surface of frond,  $\times 30$ , m. scale from lower surface,  $\times 30$  (a-f L 908.329-719, g-j SARASIN 954, k NGF 19082, l-m CLEMENS 29064).

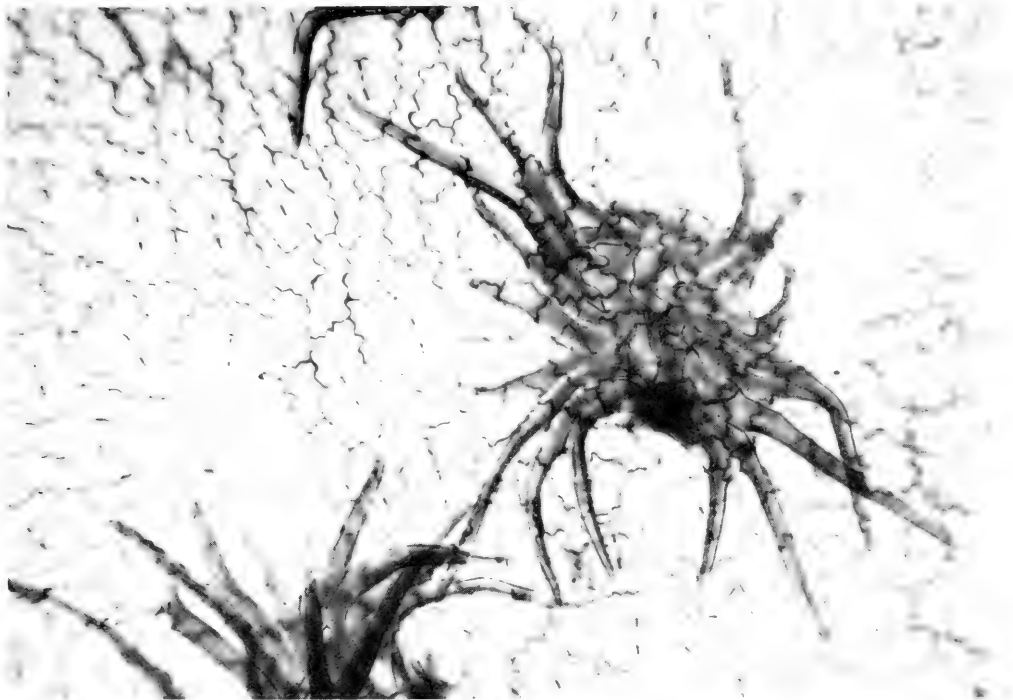


Fig. 24. *Elaphoglossum heterolepium* v.A.v.R. Lower surface of frond, showing scales and cells of epidermis,  $\times 175$ .

stipe somewhat longer than sterile; lamina 15–30 cm long, 9–15 mm wide.

Distr. *Malesia*: N. Borneo, Celebes, New Guinea.

Ecol. Epiphyte or on rocks, at 1000–2300 m.

Note. The type does not include a fertile frond; with it in the same collection are two fronds of *E. blumeanum*, which appears usually to occur at lower altitudes than *E. heterolepium* in Borneo and Celebes.

**50. *Elaphoglossum resiniferum* HOLTUM**, *Blumea* 14 (1966) 324. — Type: WAKEFIELD 1466, Papua, Central Division, Astrolabe Range (BM).

*Rhizome* creeping, 4–5 mm  $\varnothing$ , bearing fronds close together; scales dark brown, glossy, 2–3 mm long, not acuminate, somewhat crisped; phyllopodia less than 5 mm long. *Sterile frond*: stipe 5–7 cm long, pale, almost covered with appressed broadly ovate subentire brown scales less than 1 mm long; lamina thinly coriaceous, 20–26 cm long, 8–9 mm wide, widest about middle, narrowed gradually to decurrent base and caudate apex; edge reflexed and inrolled when dry; veins distinct on lower surface; costa rounded and raised beneath; scales on upper surface of costa as stipe but with short marginal projections of one cell; on upper surface of lamina few persistent scales, same shape as on costa but thin, pale, with short marginal unicellular hairs; on lower surface many small spots of dark reddish resin, apparently on sites of former

scales. *Fertile frond*: stipe 11 cm; lamina 18 cm by 7 mm, widest above middle, base gradually and narrowly decurrent, apex not caudate.

Distr. *Malesia*: E. New Guinea. Only known from type specimen.

Ecol. On wet rocks in creek bed, at 2400 m.

Species not occurring in Malesia

***Elaphoglossum conforme* (Sw.) J. SMITH** in Hook. J. Bot. 4 (1841) 148. — *Acrostichum conforme* Sw. Syn. Fil. (1806) 10, 192.

This species is confined to St Helena (type) and South Africa. The name has been used confusedly for species in various other parts of the world, including Malesia; HOOKER cited *Acrostichum angulatum* BL. as a synonym of *A. conforme*. See *E. recommutatum*, no 38, *supra*.

***Elaphoglossum gorgoneum* (KAULF.) BRACK.** in Wilkes, U.S. Expl. Exp. 16 (1854) 74. — *Acrostichum gorgoneum* KAULF. En. Fil. Chamisso (1824) 63.

This species is confined to Hawaii. The specimen described and figured as *A. gorgoneum* by BLUME (Fl. Jav. Fil. 28, t. 8) is *E. angustatum* (SCHRAD.) Hieron. of South Africa. BLUME's specimen (L) was presumably collected at the Cape by someone travelling to Java, and later mixed with others collected in Java (other examples of this are cited by BACKER & POSTHUMUS, Varenfl. Java p. 144).

BLUME's specimen was subsequently re-named *Acrostichum conforme* var. *javanicum* by METTENIUS (Ann. Mus. Bot. Lugd.-Bat. 4, (1869, 292). The references to *E. gorgoneum* by v.A.v.R. (Handb. 712, Suppl. 423) are based partly on BLUME, partly on *E. pellucido-marginatum* CHRIST.

*Elaphoglossum hirtum* (Sw.) C.CHR. Ind. Fil. (1905). — *Acrostichum hirtum* Sw. in Schrad. J. Bot. 1800/2 (1801) 10. — *Acrostichum squamosum* Sw. non CAV.

A West Indian species. BEDDOME gave the name *E. squamosum* to plants from S. India and Ceylon, and included Sumatra in the distribution of the species (BEDD. Handb. 420); this statement was copied, under the name *E. hirtum*, by v.A.v.R. (Handb. 717), but I have seen no specimens of the Indian species from Sumatra and do not know the origin of BEDDOME's statement.

*Elaphoglossum latifolium* (Sw.) J.SM. Lond. J. Bot. (1842) 197. — *Acrostichum latifolium* Sw. Prodr. (1788) 128.

A tropical American species, described originally from Jamaica. BEDDOME (Handb. 416) so named plants of *E. angulatum* (BL.) MOORE in Ceylon and S. India which he had previously called *E. laurifolium*.

*Elaphoglossum laurifolium* (THOUARS) MOORE, Ind. Fil. (1857) xvi. — *Acrostichum laurifolium* THOUARS, Fl. Tristan d'Ac. (1804) 31.

Confined to Tristan d'Acunha. The use of this name for species in other parts of the world has caused much confusion; in Malesia the species *E. angulatum* and *E. commutatum* have been so named. BACKER & POSTHUMUS (Varenfl. Java p. 251) have cited *Acrostichum gorgoneum* BL. and several other species as synonyms of *E. laurifolium*.

*Elaphoglossum pellucidum* GAUD. in Vaillant, Voy. Bonite Bot. Atlas (1844) t. 79, f. 5; MORTON, Contr. U.S. Nat. Herb. 38 (1967) 44. — *Acrostichum micradenium* FÉE, Hist. Acrost. (1845) 43, t. 8, f. 1. — *E. microphyllum* v.A.v.R. Bull. Dép. Agr. Ind. Néerl. 18 (1908) 35; BACKER & POSTH. Varenfl. Java (1939) 249.

*E. pellucidum* is a Hawaiian species. The type of *E. microphyllum* is a specimen (now in Herb. BO) from the herbarium of Dr PLOEM, who lived in Java for thirty years. The specimen bears no original label; the label written at the time of acquisition at Bogor bears the locality Java, probably on the assumption that all PLOEM's specimens were collected in Java. Other specimens from PLOEM have also been shown to bear incorrect localities (see Cyclopaedia of Collectors, Fl. Males. I, 1, 1950, xxviii, 409).

#### Doubtful species

*Acrostichum cumingii* FÉE, Hist. Acrost. (1845) 34.

FÉE cited CUMING 193 as type, but his description differs considerably from all specimens of CUMING 193 which I have seen (BM, K, P, US) in scales and in size and shape of fronds; as COPELAND has stated (Fern Fl. Philip. p. 278) FÉE's description would better fit *E. callifolium*. The specimen from which FÉE prepared his description has not been found at Paris. I therefore regard FÉE's name as of doubtful application, and have referred all specimens of CUMING 193 which I have seen to *E. luzonicum* COPEL.

*Acrostichum decurrens* DESV. Berl. Mag. 5 (1811) 310.

The type of this species is at Paris. BELL reported upon it in some detail (see *E. amblyphyllum* supra, no 30) and showed that it is not conspecific with the Java species so named by BLUME. I have also examined the specimen, which consists of small detached fronds, lacking rhizome. Its origin is described as Ind. or. I cannot identify it with any of the Malesian species of *Elaphoglossum* here described, and the specimen is so unsatisfactory that I would prefer to regard the name *E. decurrens* DESV. as a *nomen dubium*.

#### Excluded

*Elaphoglossum borneense* (BURCK) C.CHR. Ind. Fil. (1905) 303. — *Acrostichum borneense* BURCK, Ann. Jard. Bot. Btzg 4 (1884) 99 = *Syngramma borneensis* (HOOK.) J.SM. (*Gymnogramma borneensis* HOOK.).

It is to be noted that the species of BURCK and HOOKER were based on different types, but they are undoubtedly conspecific.

#### Names which should not be recognized

JOHN SMITH regarded the generic name *Elaphoglossum* as having been published by SCHOTT in 1834, but as SCHOTT gave no description the publication has no status according to the present Code. The first publication of the name with a description was by SMITH himself, in Aug. 1841. But a few months previously JOHN SMITH had published two new binomials, transferring species from the genus *Acrostichum* to *Elaphoglossum*. These two binomials are therefore now regarded as *nomina nuda*, but they have been recognized by some authors, owing to the fact that the invalidity of SCHOTT's name has only recently been noticed (it was considered valid by CHRISTENSEN, in Index Filicum). These names are therefore cited below, to indicate their status.

*Elaphoglossum blumeianum* J.SM. in Hook. J. Bot. 3 (May 1841) 401, *nom. nud.*

*Elaphoglossum obtusifolium* J.SM. l.c., *nom. nud.*

### 6. BOLBITIS<sup>1</sup>

SCHOTT, Gen. Fil. (1835) *ad t.* 13; C.CHR. Ind. Fil. Suppl. 3 (1934) 102; BACKER & POSTH. Varenfl. Java (1939) 80; COPEL. Gen. Fil. (1947) 115; HOLTUM, Ferns

(1) Treatment by E. Hennipman, Leyden.

Malaya (1954) 461; COPEL. Fern Fl. Philip. (1960) 254; HENNIPMAN, Leid. Bot. Ser. 2 (1977) 123, with full synonymy.

*Egenolfia* SCHOTT, Gen. Fil. (1835) *ad t.* 16; BACKER & POSTH. Nat. Tijds. N. I. 93 (1933) 152; Varenfl. Java (1939) 84; HOLTUM, Ferns Malaya (1954) 459; COPEL. Fern Fl. Philip. (1960) 265. — *Polybotrya* sect. *Egenolfia* DIELS in E. & P. Nat. Pfl. Fam. 1 (1900) 195; v.A.v.R. Handb. Mal. Ferns (1908) 722.

*Campium* PRESL, Tent. Pterid. (1836) 238, pl. 10 (22–23); COPEL. Philip. J. Sc. 37 (1928) 341, *p.p.*; BACKER & POSTH. Nat. Tijds. N. I. 93 (1933) 157, *p.p.*

*Edanyoa* COPEL. Philip. J. Sc. 81 (1952) 22, pl. 17. — Fig. 25, 26a–c, 27–33.

Rhizome creeping or low-climbing, unbranched or with accessory branches dorsally (and laterally), with 2–6 rows of fronds, ventrally (and laterally) with roots; scales  $\pm$  appressed, pseudo-peltate, triangular from a perfoliate or subcordate base, up to 15 mm long, usually subclathrate, sometimes (in *B. sinuata*)  $\pm$  opaque, with sparsely set, slender, uniseriate, thin-walled glandular hairs; vascular system dorsiventric, with a broad gutter-shaped ventral bundle and 1–3 (in *B. heteroclita* rarely up to 4) dorsal bundles (fig. 25d). *Fronds* usually close together, in *B. heteroclita* sometimes spaced; petiole (long-) decurrent on the rhizome, near the lamina base with 1(–3) median and on either side a lateral longitudinal ridge (fig. 25e), aerophores linear, pale, present laterally on either side and especially conspicuous in the basal part of young fronds, in cross-section near the base with a  $\pm$  U-shaped arrangement of 3–16 vascular bundles of which the two anterior ones are largest. *Sterile fronds* simple or (bi)pinnate with the pinnae alternate or  $\pm$  opposite and usually continuous with the rachis, in some species  $\pm$  subarticulate, the two lowermost pinnae usually conform to the other pinnae, sometimes deltoid, sessile or shortly petiolulate, usually herbaceous, sometimes coriaceous, with usually one, rarely more subterminal or terminal bulbils, surface when young apart from scales densely set with uniseriate glandular hairs; *venation pattern*: veins free (*ser. Egenolfianae*) or variously anastomosed and with or without included free veins in the areoles. *Fertile fronds* of similar shape as the sterile ones though with a proportionally larger petiole and a smaller lamina, usually completely acrostichoid, sometimes pteridoid or moniliform; spores with a thin exospore and a variously shaped perispore (fig. 26a–c). — Chromosomes  $n = 41, 82; 2n = 82, 123$ .

Distr. Pantropic. In my monograph (*l.c.*) I recognized 44 species arranged in 10 series (of which only *ser. Bolbitianae* is pantropic): Africa incl. Madagascar: 9 *spp.*, Asia and the Pacific: 21 *spp.* of which 12 in Malesia, Australia (Queensland): 3 *spp.*

Fossils. No fossils can be attributed to the genus. *B. coloradica* R. W. BROWN from the Cretaceous has now been recognized by REVEAL *et al.* (Bringham Young Univ. Geol. Stud. 14, 1967, 239) as a drynarioid fern, and transferred by them to *Astralopteris*.

Ecol. The species are all forest ferns; most of them grow in seasonally dry forest, others in everwet habitats. They mostly occur at low altitude, only a few species being sometimes found above 1500 m. The greater part of the species occur on rocks and especially in stream-beds, a naturally disturbed habitat. Some otherwise terrestrial species are sometimes also found as low-climbers (or as low-epiphytes). Some species are not rarely reported to form pure stands of many closely aggregated plants in forests (*B. sinensis*). Of *B. heteroclita* several forms occur which may cover (rocks of) stream-banks completely (HOLTUM, Ferns Malaya, 1954, 463), one of these being an autotriploid.

Morph. The morphology, in particular of the Indian species, has been studied by NAYAR *c.s.* (for references see KAUR, J. Linn. Soc. Bot. 68, 1974, 153–162). In my monograph an elaborate treatment of the morphology and anatomy of all species is included to which the reader is referred for details.

The rhizome of some species bears  $\pm$  conspicuous buds situated on the posterior side of the leaf-bases; they may develop into accessory branches. The stele is a dorsiventral dictyostele with wide overlapping leaf-gaps. The traces running into the buds or the accessory branch traces are situated at the posterior



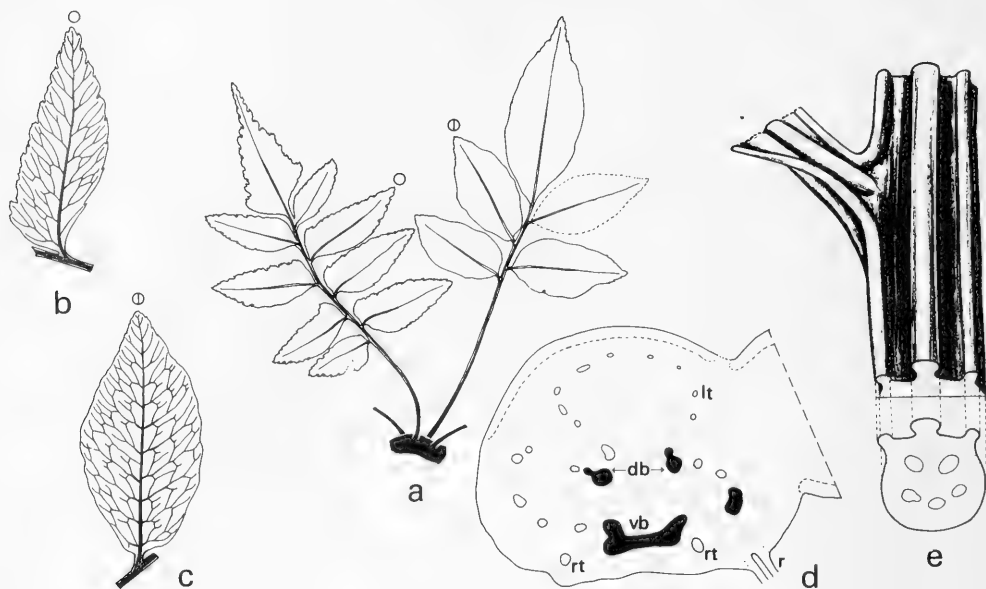


Fig. 25. *Bolbitis virens* (HOOK. & GREV.) SCHOTT. *a.* Juvenile plant,  $\times \frac{1}{2}$ , *b-c.* pinnae, nat. size. — *B. heteroclita* (PRESL) CHING. *d.* CS of rhizome,  $\times 4$ ; db = dorsal bundle, lt = leaf trace, r = root, rt = root trace, vb = ventral bundle. — *B. virens.* *e.* Adaxial view on junction of rachis with pinnae, and CS of lower part of rachis,  $\times 7$  (*a-c* HENNIPMAN 3320, *d* MANN *s.n.*, *e* HENNIPMAN 4047).

side of the two lateral leaf-gaps only, and are formed in association with root traces and leaf traces in an obviously characteristic arrangement.

*Aerophores* are part of the fronds but are continuous on the rhizome for some length. On the rhizomes of living material they show much variation in shape and size.

The *venation pattern* provides important characteristics for the discrimination of taxa. In all the species the secondary veins run parallel; typical differences are therefore expressed by the tertiary *etc.* veins only. See fig. 27, 31g, j, k. The venation in the pinnate fronds is anadromic.

Within the genus different types of venation occur. Veins are free in *ser. Egenolfianae*. In *ser. Heteroclita* and *ser. Quoyanae* the pattern is sagenioid; the veins anastomosing in a reticulate pattern, with  $\pm$  isodiametric or elongate, angulate areoles, and generally without recurrent included free veins. In *ser. Bolbitianae* the veins anastomose to form a costal areole and one to many smaller distal ones, the veins near the margin running  $\pm$  parallel, the areoles with or without excurrent included free veins.

A so-called irregular venation, *i.e.* a venation in which the arrangements of the veins in the areas included by the secondary veins are markedly different, is often (not always!) present in allopolyploids, hybrids, and in crossings between cytotypes of one species.

The morphological evidence as given in my monograph indicates that divergent evolution in ferns with a sagenioid venation — the condition which I regard to represent the original condition in the genus — may lead to species having either a free venation or a venation with several types of included free, ex- and/or recurrent veins.

All species have *bulbils* subterminally (or terminally) on the sterile (and fertile) fronds. Bulbils are  $\pm$  globular, persistent structures, situated adaxially; they are covered with scales similar to those on the rhizome. Development into mature plants occurs when the apex of the mother leaf strikes the ground; under humid conditions bulbils may develop into small plants on the erect lamina. Plants grown from bulbils stay connected with the mother plant for some time ('walking ferns').

The shape of the *fertile segments* is usually about the same (though much contracted) as that of the sterile ones. The margin of the segments often lack the prominent marginal projections found in the sterile material; bulbils are less prominent or even absent. Fronds that are in part fertile and in part sterile — so-called intermediate fronds — do not rarely occur and show much variation as to the sporangial arrangement, also in one species.

The venation pattern of the fertile segments is similar to that in the sterile ones; free included veins and small areoles are however less frequent or even absent. NAYAR *c.s.* (see KAUR, *l.c.*) reported a special kind of venation pattern occurring in the fertile fronds of the present genus; this is incorrect.



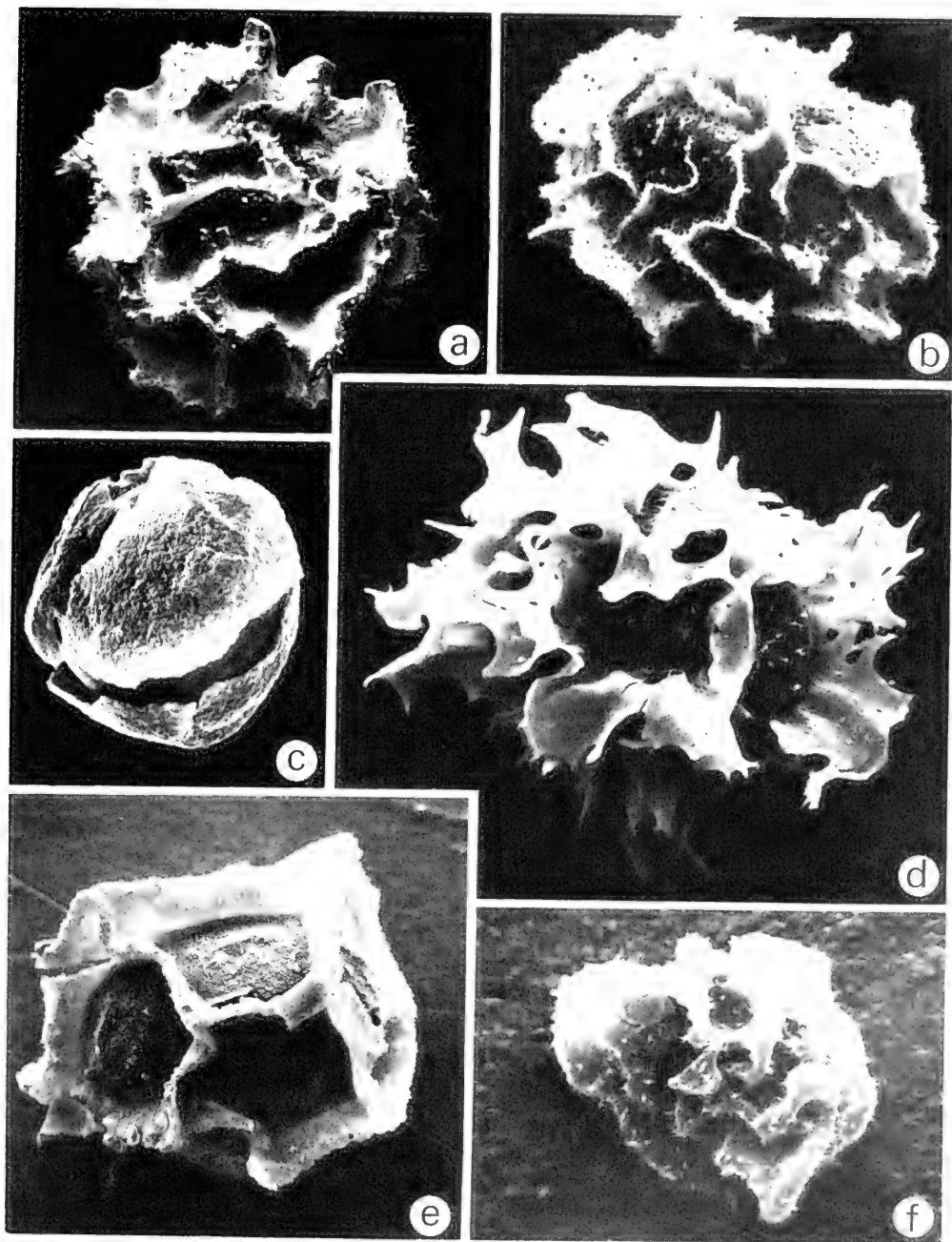


Fig. 26. Scanning electron micrographs of spores of Lomariopsidoid ferns. a. *Bolbitis sinensis*,  $\times 1000$  (HENNIPMAN 3229); b. *B. appendiculata* ssp. *appendiculata*,  $\times 1000$  (BUNAK 743); c. *B. angustipinna*,  $\times 1000$  (HENNIPMAN 3536); d. *Lomariopsis intermedia*,  $\times 500$  (BRASS 27982); e. *L. kingii*,  $\times 750$  (BRASS 32384); f. *Elaphoglossum callifolium*,  $\times 1000$  (LÖRZING 13523).

Insertion of the sporangia is variable; in some species the sporangia are situated all over the lower surface, in other species they are present on the veins only; also both conditions may be present in one species. Sporangia are formed in dense masses. In spite of the basipetal development of the fertile frond, sporangia of all parts of the frond reach maturity at the same time.

Spores as seen with the light microscope are monolet, biconvex, and provided with a variously shaped brown perispore. The exospore is thin, structurally not differentiated, and shows a short leasura. The perispore as seen from cross-sections studied with the electron microscope (HENNIPMAN, Acta Bot. Neerl. 19, 1970, 671–680) is composed of two more or less distinct elements, of which the outer perispore can also be recognized with the light microscope. Using properties of the (outer) perispore, three types of spores can be recognized with the light microscope. In *B. appendiculata* the perispore is reticulate and cristate. A smooth and undulate perispore is a characteristic of ser. *Bolbitianae*. All other species have a smooth, cristate-undulate or cristate perispore. Although some are characterized by either a cristate or a cristate-undulate perispore, the spores of several other species display both types of perispore as well as the intermediates.

Karyology. The haploid chromosome number of a considerable number of taxa as listed in my monograph was either 41 or 82. One species (*B. sinuata*) showed a weak indication of aneuploidy. In ser. *Bolbitianae* and ser. *Egenolfianae* only diploids were found. Of 20 specimens belonging to the 4 Malaysian species of ser. *Heteroclitae* and ser. *Quoyanae*, 12 were diploids and 8 (auto)triploids; this obscured the delimitation of species of these two series in the past. Thus far apogamy has not been reported for the genus.

Gametophytes. Cordate(elongate) and elongate gametophytes have been reported by NAYAR & KAUR (Bot. Rev. 37, 1971, 295–396), ATKINSON (in Jermy c.s. J. Linn. Soc. Bot., Suppl. 1, 1973, 81) and HENNIPMAN (l.c.). The gametophytes are either naked or may bear uniseriate glandular hairs or small glandular scales (the diploid prothallus of *B. repanda*).

Juvenile fronds. The ontogenetic frond stages of several species are surprisingly diverse. During ontogenesis features of the frond may become gradually or  $\pm$  abruptly more complex when subsequent fronds on a single rhizome are compared. Abrupt changes were observed for instance in the shapes of the terminal segment and the pinnae, and the venation pattern (fig. 25a–c).

Also, comparable frond stages of different juvenile plants of one species may show variation. For instance in *B. virens* juvenile fronds were found with a triangular terminal segment (the less complex condition) and a rather intricate venation, as well as fronds showing a terminal pinna (the complex condition) but with a rather simple type of venation. This kind of variation — though often less clearly expressed — is also found in the adults. The variation in the morphology of the fronds of adult plants can to a certain extent be predicted when the morphology of the juvenile fronds is known.

Speciation. From the comparative study of the juvenile fronds it may be deduced that neoteneous processes may have played an important role. Quite a number of dwarfs formerly given distinct status (e.g. *Edanyoa difformis*) could be referred to the *B. heteroclita* complex after it was found out that the mature fronds of these dwarfs were similar to both the ontogenetic frond stages of well-developed plants and the juvenile fronds grown from bulbils attached to such plants. The juvenile fronds grown from bulbils are generally more complex than the juvenile fronds of the same size grown from sporelings.

The mature fronds of *B. appendiculata* ssp. *appendiculata* (ser. *Egenolfianae*) are surprisingly similar to the juvenile fronds with free veins as found in several Asian species of ser. *Bolbitianae*. The idea that *B. appendiculata* arose by reticence of certain juvenile characters from ser. *Bolbitianae* is supported by the occurrence of several hybrids between species belonging to the two series.

The recognition of *precocious fructification* in relation to the occurrence of morphologically different ontogenetic frond stages has been of great importance for the circumscription and phylogenetic considerations of the taxa.

Specific delimitation. Hybridisation between different species and between cytotypes of one species, auto- and allopolyploidisation is supposed to be a common phenomenon in the genus. Precocious fructification further adds to the surprising morphological variation found in several species(-aggregates).

Hybrids have aborted spores or aborted spore-mother-cells, and may multiply vegetatively (a property of all Malaysian taxa).

Taxonomy. The genus *Bolbitis* was founded by SCHOTT (Gen. Fil. 1835, ad t. 13) for a part of *Acrostichum* with a creeping rhizome and anastomosing veins. At the same time (l.c. ad t. 16) he accommodated the Asian species with free veins in *Egenolfia*, keeping the American free-veined species separate in *Polybotrya*. PRESL (Tent. Pterid. 1836) and FÉE (Hist. Acrost. 1845) referred the species to several different genera whereas HOOKER (Spec. Fil. 5, 1864) and BAKER (in Hooker & Baker, Syn. Fil. 1865–1868) merged all acrostichoids again in *Acrostichum*. In spite of J. SMITH (Gen. Fil. 1875) who reinstated *Egenolfia*, CHRIST (Farnkräuter der Erde, 1897) and DIELS (in E. & P. Nat. Pfl. Fam. 1, 4, 1899) referred all the free-veined species again to *Polybotrya*, those with anastomosing veins to the heterogeneous *Gymnopteris*. CHRISTENSEN (Ind. Fil. 1906) recognized *Egenolfia*, including the other species in an assemblage he called *Leptochilus*. COPELAND (Philip. J. Sc. 37, 1928, 333–416) attempted to clear up the heterogeneities called *Gymnopteris* by DIELS and *Leptochilus* by CHRISTENSEN. He referred the Old World species to *Campium* in which he included a number of unrelated ferns as well. CHING (Bull. Fan Mem. Inst. Biol. 2, 1931, 297–317) monographed *Egenolfia*. He later (in Christensen, Ind. Fil. Suppl. 3, 1934) reinstated *Bolbitis* and largely delimited the genus as presented in my book. IWATSUKI (Acta Phytotax. Geobot. 18, 1959, 44–59) studied the Japanese species and was the first to unite *Egenolfia* and *Bolbitis*. The emended genus he divided into 4 sections. In my monograph most of the species are accommodated in 10 series (4 in Asia all except ser. *Bolbitianae* endemic), whereas several species of hybrid origin are separately ranked as *species incertae sedis*.

Notes. The treatment of the 12 recognized species is followed by the record of 5 hybrids and 2 dubious species. Of the latter two categories only those have been inserted in the key which were collected in more than one locality. Their numbers are preceded by **H** and **D** respectively.

The synonymy has been restricted to those names which were used for Malesian taxa. No types are cited because they seem not useful for botanists consulting this Flora. For full synonymy and types see my monograph.

So-called intermediate fronds, dwarfs and aberrant specimens are generally not considered in the descriptions.

The term segment is used for a portion of the lamina that has an axis and is not a pinna. Of the (central) segments the index (length/width ratio) is generally given.

The number of pinnae given refers to the total number of pinnae to a frond.

Caudate apices of pinnae are not included in the measures given for the length of the pinnae.

Primordia of bulbils can be traced when the sterile fronds are examined in transmitted light. They appear as small knobs terminally or subterminally.

The costa of the pinna and the simple lamina are termed the primary vein; the pinnately arranged lateral veins are designated as the secondary veins.

Chromosome numbers given are taken from the list supplied in my monograph.

The key to the species is based on characters of the sterile fronds, and sometimes on those of the spores.

Identification will be possible for most of the material using a good hand lens and preferably also a source of transmitted light to study the venation pattern.

# KEY TO THE SPECIES AND HYBRIDS<sup>1</sup>

1. Plants small (dwarfed) and/or fronds simple.
  2. Bulbil  $\pm$  terminal. Pinnae 16–30 . . . . . **11. B. novoguineensis**
  2. Bulbils subterminal (or absent). Pinnae less.
    3. Veins irregularly anastomosing, usually with many ex- and recurrent free veins. Fronds entire or (bi)trifid . . . . . **H.5. Leptochilus  $\times$  trifidus**
    3. Veins regularly anastomosing, without free veins or with few ex- and recurrent free veins. Fronds entire.
      4. Fronds coriaceous.
        5. Areoles (except the costal one) all of about the same shape, decreasing in size towards the margin . . . . . **10. B. rivularis**
        5. Areoles of different size and shape, not decreasing in size towards the margin . . . . . **8. B. sinuata**
      4. Fronds herbaceous (to subcoriaceous).
        6. Fronds pinnate. Venation of terminal segment as in fig. 31j, k . . . . . **9. B. quoyana**
        6. Fronds entire or if pinnate with a venation as in fig. 31g or simpler . . . . . **7. B. heteroclita**
  1. Plants not dwarfed. Fronds pinnate.
    7. Veins free.
      8. Bulbil  $\pm$  terminal on the lamina. Spines on the margin of the pinnae  $\pm$  flattened at their bases. Base of pinnae symmetrical . . . . . **5. B. rhizophylla**
      8. Bulbil subterminal on the lamina. Spines on the margin not flattened at their bases. Base of pinnae symmetrical or asymmetrical.
        9. Perispore smooth. Base of pinnae symmetrical, margin lobed  $1/3$ – $2/3$  ( $-3/4$ ) towards the costa . . . . . **6. B. sinensis**
        9. Perispore reticulate. Base of pinnae either symmetrical or asymmetrical; if symmetrical, margin of the pinnae entire or lobed to  $1/3$  ( $-1/2$ ) towards the costa . . . . . **4. B. appendiculata**
    7. Veins anastomosing.
      10. Fronds  $\pm$  coriaceous.
        11. Terminal segment conform to the pinnae, though usually larger . . . . . **8. B. sinuata**
        11. Terminal segment triangular . . . . . **10. B. rivularis**
      10. Fronds herbaceous.
        12. Fronds drying reddish. Perispore undulate . . . . . **2. B. sculpturata**
        12. Fronds drying greenish. Perispore undulate, cristate-undulate, or cristate.
          13. Terminal segment conform to the pinnae or composed of 2 or 3 lobes.
            14. Venation pattern with many excurrent included free veins.
              15. Perispore undulate . . . . . **3. B. virens var. compacta**
              15. Perispore cristate . . . . . **D.1. B. interlineata**
            14. Venation pattern without or with only few excurrent (and recurrent) included free veins.
              16. Pinnae 2–10 (–15) to a frond . . . . . **7. B. heteroclita**
              16. Pinnae more than 15 to a leaf . . . . . **1. B. angustipinna**
          13. Terminal segment triangular.
            17. Bulbil  $\pm$  terminal. Small plant . . . . . **11. B. novoguineensis**
            17. Bulbil subterminal.
              18. Terminal segment narrowly triangular. Perispore undulate . . . . . **1. B. angustipinna**
              18. Terminal segment triangular. Perispore cristate or cristate-undulate.

(1) Only hybrids known from more than one locality are included.

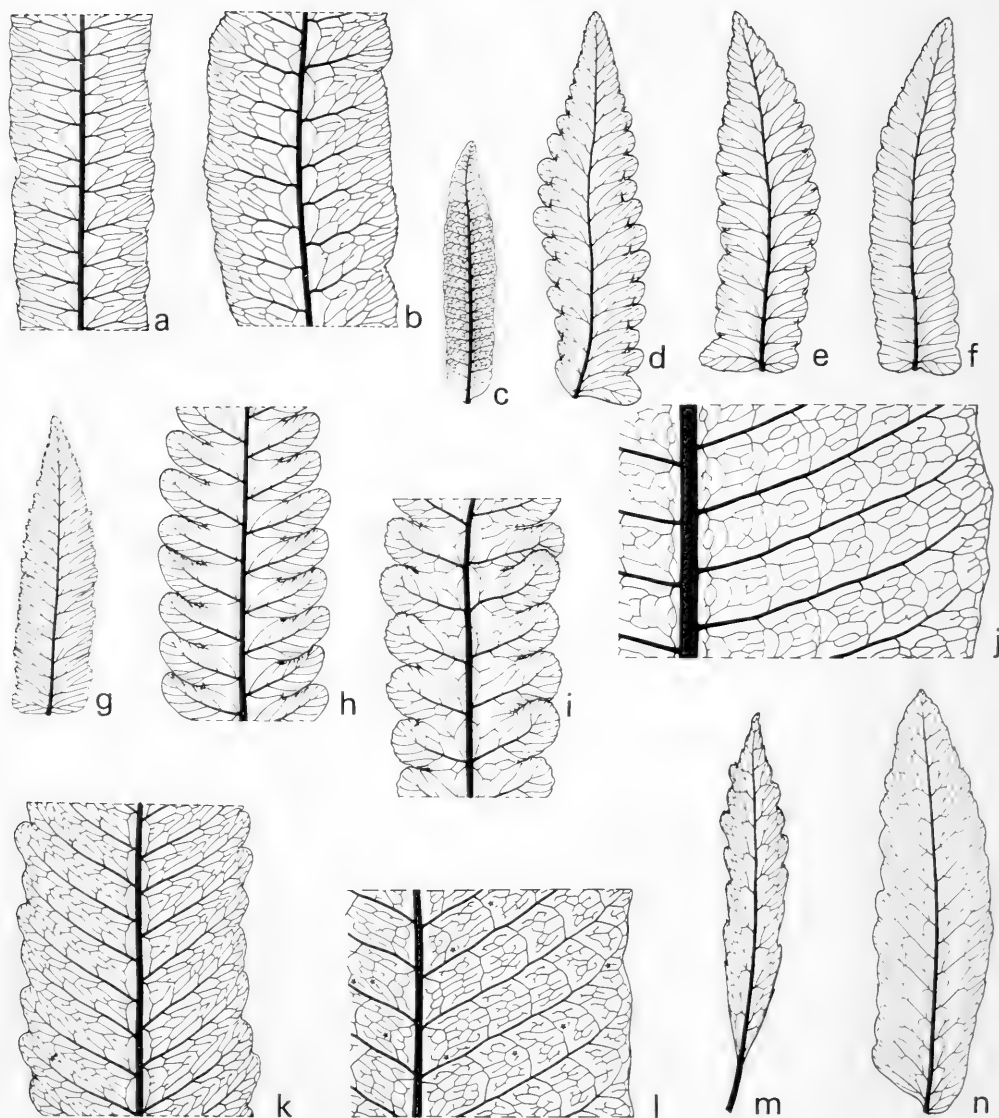


Fig. 27. Venation patterns of sterile (a-b, d-n) and fertile (c) pinnae,  $\times \frac{4}{5}$ . a. *Bolbitis angustipinna* (HENNIPMAN 3637); b. *B. sculpturata* (MOUSSET 562); c. *B. virens* var. *compacta* (SF 29084); d. *B. appendiculata* ssp. *appendiculata* (HOLTUM s.n., SING); e-f. *B. appendiculata* ssp. *vivipara* var. *neglecta* (VAN BORSSUM WAALKES 603); g. *B. rhizophylla* (LEROY TOPPING 655); h. *B. sinensis* (HENNIPMAN 3229A); i. *B. repanda* (SF 25585); j. *B. sinuata* (JOHNSON s.n., L); k. *B. interlineata* (BROOKS 12); l. *Leptochilus*  $\times$  *trifidus* (VAN ALDERWERELT VAN ROSENBURGH s.n., L); m. *B. sinuosa* nm. *foxii* (PNH 8904); n. *B. singaporensis* (HOLTUM s.n., SING).

19. Venation pattern irregular. See fig. 27i . . . . . 12. *B. repanda*  
 19. Venation pattern regular.  
 20. Base of pinnae narrow-acute or -cuneate. Pinnae  $7\frac{1}{2}$ –12 by 1–1 $\frac{3}{4}$  cm H.4. *B. sinuosa*  
 20. Base of pinnae wider. Pinnae usually larger . . . . . 9. *B. quoyana*

### 1. Series *Bolbitianae*

HENNIPMAN, Leid. Bot. Ser. 2 (1977) 147. — *Bolbitis* SCHOTT, Gen. Fil. (1835) *ad t. 13, typo incl., pro genere*.

Sterile fronds pinnate; lamina with a (primordium of a) subterminal bulbil; pinnae 3–50, the margin sometimes with inconspicuous spines in the sinuses; terminal segment usually conform to the pinnae, sometimes narrowly triangular; venation pattern: veins variously anastomosing, always with a costal areole, with or without excurrent included free veins. Spores with a smooth, undulate perispore. — Chromosomes  $n = 41$ ,  $2n = (c.)$  82.

Distr. Pantropical; most diversified in Asia (7 spp., of which 3 in *Malesia*).

Note. A very homogeneous series. *B. angustipinna*, the most widespread Asian representative, is most closely related to the species from America and Africa.

1. *Bolbitis angustipinna* (HAYATA) ITO, J. Jap. Bot. 14 (1938) 443; HENNIPMAN, Leid. Bot. Ser. 2 (1977) 152, f. 40a–f. — *Leptochilus angustipinnus* HAYATA, Ic. Pl. Form. 5 (1915) 297, f. 119. — *Campium angustipinnum* COPEL. Philip. J. Sc. 37 (1928) 381, f. 33.

*Leptochilus cuspidatus* (PRESL) C. CHR. var. *crenatus* ROSENST. Hedwigia 56 (1915) 348.

[*Acrostichum contaminans* WALL. Cat. (1829) n. 22, nomen. — *Poecilopteris contaminans* MOORE, Ind. Fil. (1857) 8, nomen.] — *Acrostichum crispatum* CLARKE var. *contaminans* CLARKE, Trans. Linn. Soc. Bot. 1 (1880) 580, pl. 84: f. 2A, 2C. — *B. contaminans* CHING in C. Chr. Ind. Fil. Suppl. 3 (1934) 47; IWATSUKI, Acta Phytotax. Geobot. 18 (1959) 53, f. 9; DeVOL & KUO, Fl. Taiwan 1 (1975) 348. — Fig. 26c, 27a.

Sterile fronds pinnate, 55–150 cm long; lamina index 1–3, 30–90 by 20–45 cm, terminal segment 8–25 cm long, (firm) herbaceous, usually light to dark green, sometimes with a purple tinge; pinnae 20–50, index 5–12, the central part usually with parallel margins, 11–30 by 2–3(–5) cm, base  $\pm$  symmetrical, acute, broadly attenuate or truncate, margin usually slightly serrate-crenate, sometimes lobed to  $\frac{1}{3}$  to the costa and with a short or inconspicuous spine in each sinus; terminal segment usually narrowly triangular, sometimes  $\pm$  conform to the central pinnae; venation pattern: veins forming a costal areole and one to several rows of distal areoles, included free veins absent, the veins in the marginal strip excurrent and parallel; see fig. 27a. Fertile fronds 55–160 cm long; pinnae index (6)–9–20, 5–23 by 0.4–1.7 cm. Sporangia situated usually all over the lower surface, sometimes with a sterile strip along the costa. Spores smooth, undulate.

Distr. Ceylon, Himalayas eastwards to S. China and Taiwan, southwards to N. Thailand; in *Malesia*: Philippines (Luzon), one collection.

Ecol. On rocks in monsoon and evergreen forest, 250–1500 m.

2. *Bolbitis scalpturata* (FÉE) CHING in C. Chr. Ind. Fil. Suppl. 3 (1934) 50; BACKER & POSTH. Varenfl. Java (1939) 82, p.p.; POSTH. Ann. Bot. Gard. Btzg vol. hors série (1944) 62; HENNIPMAN, Leid. Bot. Ser. 2 (1977) 163, f. 43a–d. — *Heteroneuron scalpturatum* FÉE, Hist. Acrost. (1845) 95, pl. 56, p.p. — *Leptochilus scalpturatus* C. CHR. Ind. Fil. (1906) 387, p.p.; v.A.V.R. Handb. Mal. Ferns (1908) 743, p.p. — *Campium scalpturatum* COPEL. Philip. J. Sc. 37 (1928) 383, f. 35; BACKER & POSTH. Nat. Tijds. N. I. 93 (1933) 162.

*Leptochilus reimersii* RENSCH, Hedwigia 74 (1934) 249, pl. 7: f. 2. — Fig. 27b.

Sterile fronds pinnate, 25–90 cm long; lamina index 1–3, 20–55 by 7–30 cm, terminal segment 9–20 cm long, herbaceous to subcoriaceous, purplish or purplish-brown; pinnae 4–24, index 3–7, 5.5–17.5 by 1.5–4 cm, base  $\pm$  symmetrical, narrowly to broadly cuneate, margin  $\pm$  entire or finely serrate-crenate, without spines, apex acute to (long-)acuminate; terminal segment usually conform to the central pinnae, sometimes narrowly triangular and/or somewhat prolonged; venation pattern: veins forming a network of a costal areole and one to few transverse rows of smaller distal ones, part of the areoles with few to several, mostly excurrent included free veins; see fig. 27b. Fertile fronds 30–70 cm long; pinnae index 3–8, 3–9 by 0.6–1.5 cm. Sporangia inserted mostly on and near the veins, either all over the lower surface, arranged acrostichoid, or along the margin only, arranged peritridoid. Spores smooth, undulate.

Distr. E. Burma to Indo-China; in *Malesia*: S. Sumatra (Lampongs), E. Java (Mt Tengger), Lesser Sunda Is. (Bali, Sumbawa, Flores), S. Celebes (also Saleyer Is.), Philippines (Palawan, Luzon).

Ecol. Showing a preference for a seasonal climate, 0–1200 m.

Note. A somewhat critical species. The venation pattern shows considerable variation; it may come near to that of *B. angustipinna* or *B. virens*.

3. *Bolbitis virens* (HOOK. & GREV.) SCHOTT, Gen. Fil. (1835) *ad t. 13*; HOLTUM, Ferns Malaya (1954) 468, f. 275, p.p. — *Campium virens* PRESL, Tent. Pterid. (1836) 239; COPEL. Philip. J. Sc. 37 (1928) 388; HENNIPMAN, Leid. Bot. Ser. 2 (1977) 180, f. 47 & 48. — *Leptochilus virens* C. CHR. Ind. Fil. (1906) 388, p.p.; v.A.V.R. Handb. Mal. Ferns (1908) 741, p.p.; *ibid.* Suppl. (1917) 435, p.p.

var. *compacta* HENNIPMAN, Blumea 18 (1970) 149; Leid. Bot. Ser. 2 (1977) 184, f. 48i, j. — Fig. 25a–c, e, 27c.

Sterile fronds pinnate, 40–115 cm long; lamina index 1–3, 20–75 by 15–50 cm, terminal segment 14–40 cm long, firm herbaceous; pinnae 6–22, index 3–7, 10–30 by 2.5–6.5 cm, base  $\pm$  symmetrical, usually narrowly, sometimes broadly attenuate or cuneate, margin usually  $\pm$  entire, sometimes (bi)serrate or (bi)serrate-crenate; terminal segment conform to the pinnae or somewhat prolonged; venation pattern: veins forming a costal

areole and several to many equally large distal ones, the arches with two or more excurrent free veins. *Fertile fronds* 40–125 cm long; central pinnae index 3–8, 4–11.5 by 0.8–2 cm. *Sporangia* inserted all over the lower surface. Spores smooth, undulate.

Distr. ?India (Nicobar Is.), S. Vietnam, Peninsular Thailand; in *Malesia*: Malay Peninsula (Kedah, Selangor, Penang, Langkawi Is.). Fig. 28.

Ecol. Usually on rocks and often near streams in (dry) evergreen forest, 0–400(–700) m.

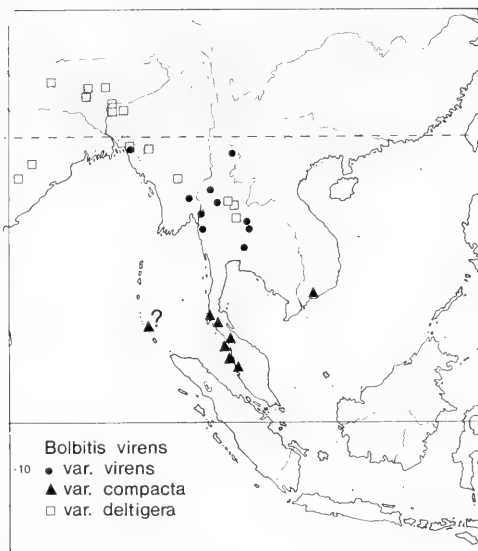


Fig. 28. Range of *Bolbitis virens* (HOOK. & GREV.) SCHOTT.

## 2. Series Egenolfianae

HENNIPMAN, Leid. Bot. Ser. 2 (1977) 185. — *Egenolfia* SCHOTT, Gen. Fil. (1835 or 1836) *ad r.* 16, *typo incl., pro genere.*

Sterile fronds pinnate; lamina with one, usually subterminal, in one species (*B. rhizophylla*) ± terminal bulbil; pinnae 14–90, the margin with spines corresponding to the most distal acroscopic tertiary vein of each secondary vein; terminal segment triangular; venation: veins free. Spores with either a smooth, cristate or cristate-undulate perispore, or with a reticulate ± cristate perispore. — Chromosomes  $n = 41$ ,  $2n = 82$ .

Distr. S. India and Ceylon to *W. Malesia*, northwards to S. Japan.

4. *Bolbitis appendiculata* (WILLD.) IWATSUKI, Acta Phytotax. Geobot. 18 (1959) 48; HENNIPMAN, Blumea 18 (1970) 147; Leid. Bot. Ser. 2 (1977) 185, f. 49. — *Acrostichum appendiculatum* WILLD. Sp. Pl. 5 (1810) 114; HOOK. Exot. Fl. 2 (1825) 108, pl. 108; Sp. Fil. 5 (1864) 251, *p.p.*; BAKER in HOOK. & BAKER, Syn. Fil. (1868) 415. — *Polybotrya appendiculata* J. SMITH, Hook. J. Bot. 4 (1841) 150; v.A.v.R. Handb. Mal. Ferns (1908) 724, *p.p.* — *Egenolfia appendiculata* J. SMITH, Ferns Br. For. (1866) 111, fig.; BACKER & POSTH. Nat. Tijd. N. I.

93 (1933) 153; Varenfl. Java (1939) 84, f. 14; HOLTUM, Ferns Malaya (1954) 459, f. 270; COPEL. Fern Fl. Philip. (1960) 266; DEVOL & KUO, Fl. Taiwan 1 (1975) 350, pl. 123.

*Polybotrya vivipara* HAM. ex HOOK. Exot. Fl. 2 (1825) 107, pl. 107. — *Egenolfia vivipara* C. CHR. Ind. Fil. Suppl. 3 (1934) 102. — *B. hookeriana* IWATSUKI, Acta Phytotax. Geobot. 18 (1959) 49. — *B. appendiculata* (WILLD.) IWATSUKI *ssp. vivipara* HENNIPMAN, Blumea 18 (1970) 147; Leid. Bot. Ser. 2 (1977) 195, f. 50, 51.

*Polybotrya marginata* BL. En. Pl. Jav. (1828) 100, *nom. superfl.*; Fl. Java Filices (1829) 18, pl. 3; FÉE, Hist. Acrost. (1845) 75. — *Polybotrya appendiculata* (WILLD.) J. SMITH *var. marginata* C. CHR. Bot. Tidsskr. 32 (1916) 343.

[*Acrostichum hamiltonianum* WALL. Cat. (1829) n. 28, *nomen.*] — *Polybotrya hamiltoniana* [PRESL, Tent. Pterid. (1836) 236, *nomen.*;] FÉE, Hist. Acrost. (1845) 78, *nom. superfl.* — *Egenolfia hamiltoniana* FÉE, Genes Polyp. (1852) 48, *non* SCHOTT, 1835 or 1836 (= *B. appendiculata ssp. appendiculata*). — *Acrostichum appendiculatum* WILLD. *var. hamiltonianum* BAKER in HOOK. & BAKER, Syn. Fil. (1868) 415. — *Polybotrya appendiculata* (WILLD.)

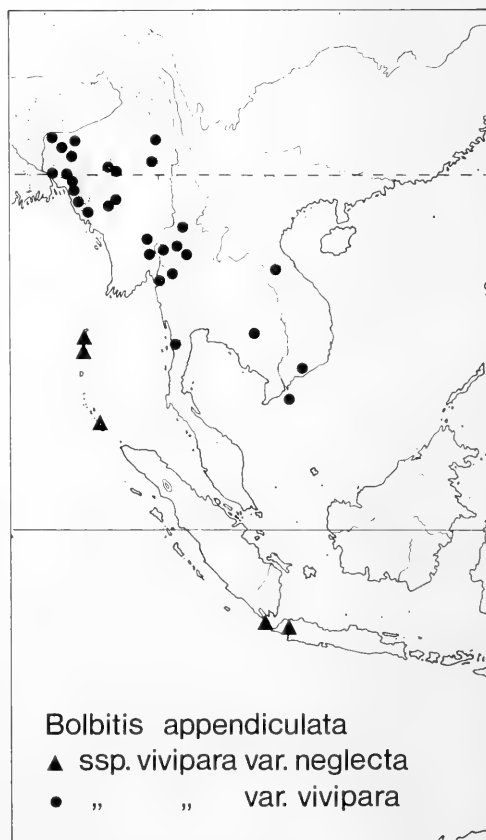


Fig. 29. Range of *Bolbitis appendiculata* (WILLD.) IWATSUKI.



*J. SMITH* var. *hamiltoniana* BEDD. Handb. Ferns Br. India (1883) 426, f. 256, p.p.; v.A.v.R. Handb. Mal. Ferns (1908) 724, *quoad nomen solum*; *ibid.* Suppl. (1917) 431, *ditto*.

*B. appendiculata* (WILLD.) IWATSUKI var. *neglecta* HENNIPMAN, Blumea 18 (1970) 147; Leid. Bot. Ser. 2 (1977) 197, f. 50i-n, 51. — Fig. 26b, 27d-f.

*Sterile fronds* pinnate, 15–100 cm long; lamina index 2–6(–8), 10–80 by 2.5–20 cm, terminal segment 1–10 cm long, herbaceous, usually olivaceous; pinnae (20–)25–60(–85), index 2–5(–7), 1.5–10(–15) by 0.5–2.5 cm, base symmetrical to strongly oblique, margin  $\pm$  entire, finely serrate, or lobed to  $1/3$  ( $1/2$ ) towards the costa; *terminal segment* triangular, apex sometimes somewhat prolonged; *venation pattern*: secondary veins on either side with 2 or 3 tertiary veins; see fig. 27d-f. *Fertile fronds* 15–90 cm long; pinnae index 1–6, 0.2–11 by 0.15–1.7 cm. *Sporangia* inserted all over the lower surface or  $\pm$  restricted to the veins. Spores with a reticulate cristate perispore. — Chromosomes  $n = 41$ ,  $2n = 82$ .

Distr. S. India and Ceylon, NE. India eastwards through SE–E. continental Asia to S. Japan; in *Malesia*: Malaya, Java, Philippines. Fig. 29.

Ecol. On rocks or in soil in deciduous and evergreen forest, 0–1500 m.

Note. The reticulate perispore is unique in the genus.

#### KEY TO INFRASPECIFIC TAXA

1. Fertile pinnae with a lamina. Sporangia situated on the lower surface of the frond
  - a. *ssp. appendiculata*
1. Fertile pinnae with a narrow strip of lamina present along the costa only. Sporangia facing to all directions
  - b. *ssp. vivipara* var. *neglecta*

a. *ssp. appendiculata* — *Acrostichum appendiculatum* WILLD. — *Polybotrya marginata* BL. — Fig. 27d.

*Sterile fronds* 15–60(–80) cm long, the rachis with a narrow wing; pinna base oblique. *Fertile fronds*: pinna index 1–6, 0.25–4 by 0.2–0.7 cm. *Sporangia* inserted mainly on the veins or all over the lower surface.

Distr. Ceylon, S. India, Himalayas eastwards to S. Japan and Indo-China; in *Malesia*: Sumatra (West Coast, Bencoolen, East Coast), Malay Peninsula, Java (West, Central). Fig. 29.

Ecol. See the species.

b. *ssp. vivipara* (HOOK.) HENNIPMAN, Leid. Bot. Ser. 2 (1977) 195. — *Polybotrya vivipara* HAM. ex HOOK. — *B. appendiculata* (WILLD.) IWATSUKI var. *neglecta* HENNIPMAN.

var. *neglecta* HENNIPMAN, Blumea 18 (1970) 147; Leid. Bot. Ser. 2 (1977) 197, f. 50i-n, 51.

*Polybotrya appendiculata* (WILLD.) J. SMITH var. *rhizophylla* auct. non (KAULF.) KUHN: KUHN, Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 225.

*Polybotrya appendiculata* (WILLD.) J. SMITH var. *hamiltoniana* auct. non (FÉE) BEDD.: v.A.v.R. Handb. Mal. Ferns, Suppl. (1917) 431. — Fig. 27e, f.

*Sterile fronds* 30–50 cm long, the rachis with a narrow or inconspicuous wing; pinna base  $\pm$  symmetrical or oblique. *Fertile fronds*: pinnae  $\pm$

moniliform, index 5–15, 0.7–3 cm long, with a narrow strip of lamina along the costa. *Sporangia* mainly inserted at the endings of the lateral veins.

Distr. India (Andaman and Nicobar Is.); in *Malesia*: West Java. Fig. 29.

Ecol. On stone, 70 m (type).

5. *Bolbitis rhizophylla* (KAULF.) HENNIPMAN, Blumea 18 (1970) 148; Leid. Bot. Ser. 2 (1977) 199, f. 52d-r, 53. — *Gymnogramma rhizophylla* KAULF. En. Fil. (1824) 78. — *Polybotrya rhizophylla* PRESL, Tent. Pterid. (1836) 231; FÉE, Hist. Acrost. (1845) 77; METT. Fil. Hort. Lips. (1856) 24. — *Egenolfia rhizophylla* FÉE, Genres Polyp. (1852) 48; COPEL. Fern Fl. Philip. (1960) 266; DEVOL & KUO, Fl. Taiwan 1 (1975) 352.

*Polybotrya intermedia* [J. SMITH, Hook. J. Bot. 3 (1841) 72, *nomen*;] FÉE, Hist. Acrost. (1845) 76, pl. 40: f. 1. — *Egenolfia intermedia* FÉE, Genres Polyp. (1852) 48; CHING, Bull. Fan Mem. Inst. Biol. 2 (1931) 308; COPEL. Fern Fl. Philip. (1960) 266. — *B. intermedia* IWATSUKI, Acta Phytotax. Geobot. 18 (1959) 49.

*Polybotrya neglecta* FÉE, Hist. Acrost. (1845) 76, pl. 39: f. ii.

*Polybotrya serrulata* [J. SMITH, Hook. J. Bot. 3 (1841) 401, *nomen*;] FÉE, Hist. Acrost. (1845) 76, pl. 39: f. ii\*. — *Egenolfia serrulata* FÉE, Genres Polyp. (1852) 358. — *B. serrulata* IWATSUKI, Acta Phytotax. Geobot. 18 (1959) 49.

*Polybotrya exaltata* BRACKENR. in Wilkes, U.S. Expl. Exp. 16 (1854) 78.

*Polybotrya duplicato-serrata* HAYATA, Ic. Pl. Form. (1915) 305, f. 123A.

*Egenolfia fluviatilis* COPEL. Philip. J. Sc. 38 (1929) 152, pl. 5; Fern Fl. Philip. (1960) 267. — *B. copeilandii* IWATSUKI, Acta Phytotax. Geobot. 18 (1959) 49, *nom. illeg.*, non CHING ex TARDIEU-BLOT & C. CHR. 1938. — Fig. 27g.

*Sterile fronds* pinnate, 20–90 cm long; lamina index 3–9, 18–80 by 4.5–15 cm, terminal segment 1–6 cm long, herbaceous, green to blackish, the petiole and lower side of the basal part of the rachis usually with small, blackish, spreading,  $\pm$  permanent scales; rachis with a narrow wing except for the lowest part; pinnae 35–90, up to 35 mm apart, index 2–6, 2.5–8 by 0.8–2 cm, base usually symmetrical, (narrowly) cuneate to subcordate, margin

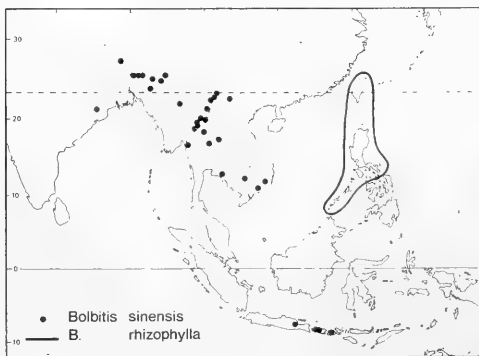


Fig. 30. Range of *Bolbitis sinensis* (BAKER) IWATSUKI and *B. rhizophylla* (KAULF.) HENNIPMAN.

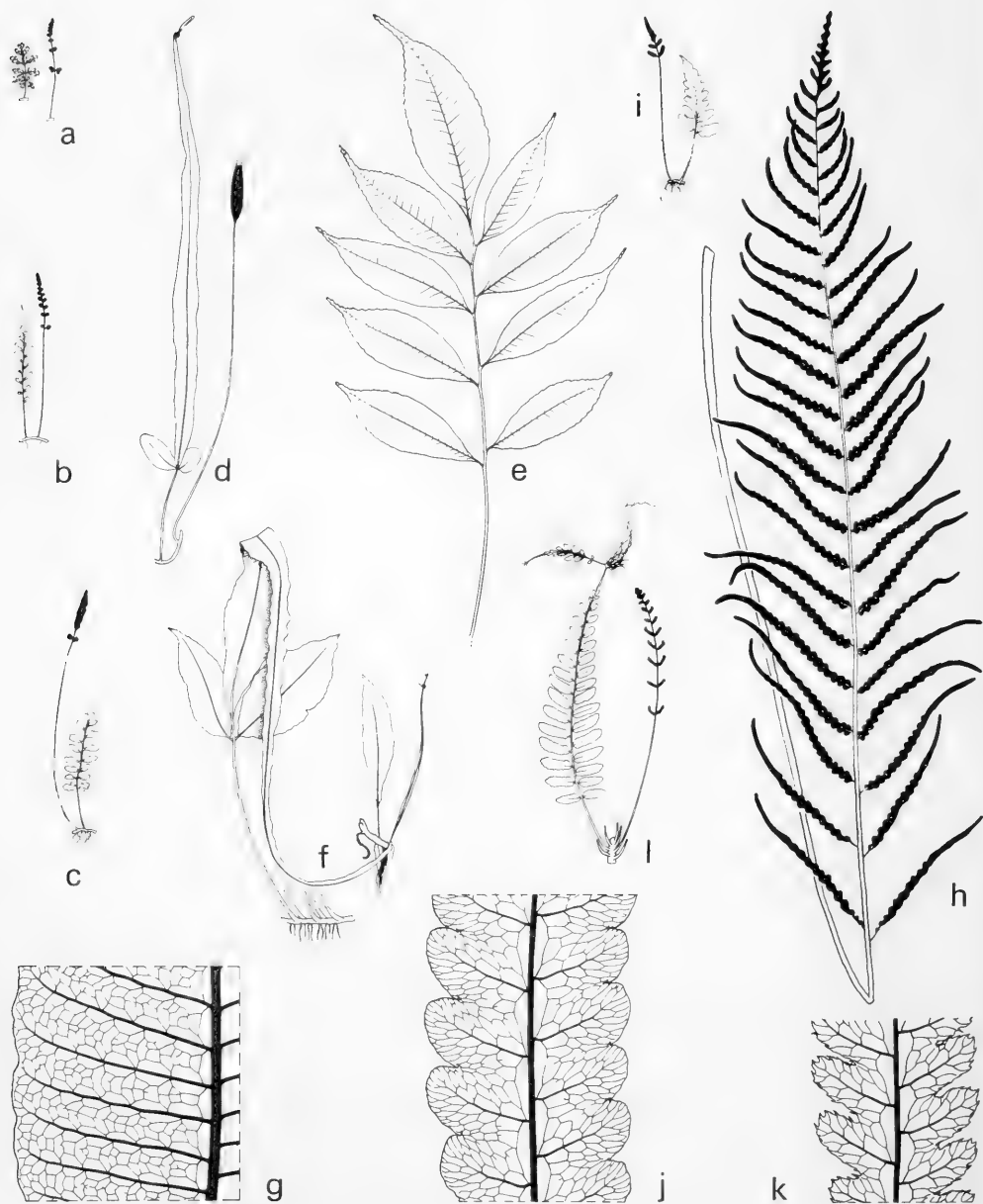


Fig. 31. *Bolbitis heteroclita* (PRESL) CHING. *a-f*. Habits,  $\times \frac{1}{5}$ , *g*. venation pattern of sterile pinna,  $\times \frac{4}{5}$ . — *B. quoyana* (GAUDICH.) CHING. *h-i*. Habits,  $\times \frac{1}{5}$ , *j-k*. venation patterns of sterile pinnae,  $\times \frac{4}{5}$ . — *B. novoguineensis* HENNIPMAN. *l*. Habit,  $\times \frac{1}{5}$  (*a* PRICE 2518A, *b* PRICE 351, *c* BS 28843, *d* PNH 8811, *e* JACOBS 7950, *f* HENNIPMAN 4069, *g* HENNIPMAN 3836, *h* WALKER T 10052, *i* SCHLECHTER 16163, *j* WALKER T 9604, *k* ELMER 13468a, *l* BRASS 28008).



finely serrate, biserrate, or serrately lobed to  $\frac{1}{3}$  towards the costa, the spines often tooth-like; *terminal segment* narrowly triangular; venation pattern: *secondary veins* on either side with 1–3 tertiary veins, see fig. 27g. *Fertile fronds* 20–80 cm long; pinnae index 1–6, 0.4–3(–4) by 0.3–0.7 cm. *Sporangia* inserted on and near the veins. Spores with a smooth cristate-undulate perispore. — Chromosomes  $n = 41$ .

Distr. Taiwan; in *Malesia*: Philippines (Balabac I., Palawan, Mindoro, common in Luzon). Fig. 30.

Ecol. On rocks in moist forests and often near riverbanks, 0–1000 m.

**6. *Bolbitis sinensis* (BAKER) IWATSUKI**, Acta Phytotax. Geobot. 18 (1959) 49; HENNIPMAN, Leid. Bot. Ser. 2 (1977) 202, f. 53, 54. — *Acrostichum sinense* BAKER, Kew Bull. (1906) 14. — *Egenolfia sinensis* MAXON, Proc. Biol. Soc. Wash. 36 (1923) 173. — *Campium sinense* C.CHR. Contr. U.S. Nat. Herb. 26 (1931) 292.

*Acrostichum appendiculatum* WILLD. var. *costulatum* HOOK. Sp. Fil. 5 (1864) 252. — *Polybotrya appendiculata* (WILLD.) J. SMITH var. *costulata* BEDD. Ferns Br. India (1865) 110, pl. 110. — *Egenolfia bipinnatifida* J. SMITH, Hist. Fil. (1875) 132; BACKER & POSTH. Varenfl. Java (1939) 85. — *B. sinensis* (BAKER) IWATSUKI var. *costulata* TAGAWA & IWATSUKI, Acta Phytotax. Geobot. 22 (1967) 102. — Fig. 27h.

*Sterile fronds* pinnate, 35–145 cm long; lamina index 1–4(–5), 20–115 by 10–35 cm, terminal segments 8–35 cm long, herbaceous, dark green,  $\pm$  glabrescent; rachis usually with a narrow wing except for the lowest part; pinnae 14–40, index 3–7, 5.5–17.5(–21) by 1.5–5 cm, base  $\pm$  symmetrical, broadly cuneate to auricled, margin lobed  $\frac{1}{3}$ – $\frac{2}{3}$ (– $\frac{3}{4}$ ) towards the costa, lobes spaced to partly overlapping, c. 6–8 mm wide at the base; *terminal segment* narrowly triangular, the apex usually either prolonged or flagelloid; *venation pattern*: secondary veins on either side with 4–6 tertiary veins, see fig. 27h. *Fertile fronds* 18–85 cm long; pinnae index 2–8, 1.3–6 by 0.4–1.2 cm. *Sporangia* usually mainly inserted on and near the veins. Spores with a smooth cristate-undulate perispore. — Chromosomes  $n = 41$ ,  $2n = 82$ .

Distr. S. China, E. Himalayas to Indo-China; in *Malesia*: E. Java (once), Lesser Sunda Is. (Bali, Sumbawa). Fig. 30.

Ecol. Usually terrestrial, creeping in soil or on rocks, sometimes low-epiphytic (up to 1 m), in (hill) evergreen (monsoon) forest, obviously a rare plant, 0–1900 m.

### 3. Series *Heteroclita*

HENNIPMAN, Leid. Bot. Ser. 2 (1977) 220.

*Sterile fronds* simple or pinnate; petiole with 3–14 vascular bundles; lamina with usually one subterminal bulbil; pinnae 2–11(–15), the margin without teeth or spines; *terminal segment* usually conform to the pinnae, sometimes (in dwarfs) triangular; venation pattern: veins usually completely anastomosing into a regular network, areoles varying in size and shape. Spores with a smooth, cristate or cristate-undulate perispore. — Chromosomes  $n = 41$ ,  $2n = 82$ ,  $c. 123$ .

Distr. NE. India to the Pacific, northwards to

S. Japan; throughout *Malesia*, except for the Lesser Sunda Is.

**7. *Bolbitis heteroclita* (PRESL) CHING** in C. Chr. Ind. Fil. Suppl. 3 (1934) 48; BACKER & POSTH. Varenfl. Java (1939) 83, f. 13; HOLTTUM, Ferns Malaya (1954) 462, f. 271; COPEL. Fern Fl. Philip. (1960) 257; CHING, Fl. Hain. (1964) 165, f. 75; DeVOL & KUO, Fl. Taiwan 1 (1975) 348, pl. 122; HENNIPMAN, Leid. Bot. Ser. 2 (1977) 221, f. 60. — *Acrostichum heteroclitum* PRESL, Rel. Haenk. (1825) 15, pl. 2: f. 2. — *Heteroneuron heteroclitum* FÉE, Hist. Acrost. (1845) 92. — *Chrysodium heteroclitum* KUHN, Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 294. — *Leptochilus heteroclitus* C.CHR. Ind. Fil. (1906) 385; v.A.V.R. Handb. Mal. Ferns (1908) 739. — *Campium heteroclitum* COPEL. Philip. J. Sc. 37 (1928) 359, f. 13; BACKER & POSTH. Nat. Tijd. N. I. 93 (1933) 163.

*Nephrodium cuspidatum* PRESL, Rel. Haenk. (1825) 31. — *Polystichum cuspidatum* PRESL, Tent. Pterid. (1836) 82. — *Heteroneuron cuspidatum* PRESL, Epim. Bot. (1851) 169. — *Chrysodium cuspidatum* KUHN, Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 293, p.p. — *Leptochilus cuspidatus* C.CHR. Ind. Fil. (1906) 384, *quoad nomen solum*. — *Campium cuspidatum* COPEL. Philip. J. Sc. 37 (1928) 365, f. 19. — *B. cuspidata* CHING in C. Chr. Ind. Fil. Suppl. 3 (1934) 48; COPEL. Fern Fl. Philip. (1960) 259.

*Acrostichum flagelliferum* WALL. ex HOOK. & GREV. Ic. Fil. (1827) pl. 23, p.p.; BL. En. Pl. Jav. (1828) 104; Fl. Java Fil. (1829) 37, pl. 13, p.p. — *B. flagellifera* SCHOTT, Gen. Fil. (1835) ad t. 13. — *Gymnopteris flagellifera* BEDD. Ferns Br. India, Suppl. (1876) 27; COPEL. Polyp. Philip. (1905) 42, p.p.

*Acrostichum proliferum* BL. En. Pl. Jav. (1828) 104, non HOOK. 1844 (= *B. subcrenata*).

*Leptochilus linnaeanus* FÉE, Hist. Acrost. (1845) 87, pl. 47: f. 2, excl. syn.; v.A.V.R. Handb. Mal. Ferns (1908) 735; Suppl. Corr. (1917) 60. — *Dendroglossa linnaeana* FÉE, Gen. Polyp. (1852) 81. — *Gymnopteris linnaeana* CHRIST, J. de Bot. 19 (1905) 125; COPEL. Polyp. Philip. (1905) 4. — *Leptochilus heteroclitus* (PRESL) C.CHR. var. *linnaeanus* CHRIST, Philip. J. Sc. 2 (1907) Bot. 160. — *Campium linnaeanum* COPEL. Philip. J. Sc. 37 (1928) 343, *quoad nomen solum*; BACKER & POSTH. Nat. Tijd. N. I. 93 (1933) 159, excl. syn. — *B. linnaeana* C.CHR. Ind. Fil. Suppl. 3 (1934) 198; BACKER & POSTH. Varenfl. Java (1939) 80.

*Cyrtogonium acuminatum* BRACKENR. in Wilkes, U.S. Expl. Exp. 16 (1854) 86.

*Poecilopteris stenophylla* KURZ ex T. & B. Nat. Tijd. N. I. 27 (1864) 15; COPEL. Philip. J. Sc. 37 (1928) 393. — *B. stenophylla* CHING in C. Chr. Ind. Fil. Suppl. 3 (1934) 50.

*Chrysodium heteroclitum* (PRESL) KUHN var. *subcrenatum* KUHN, Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 294, p.p.

*Acrostichum modestum* BAKER, J. Linn. Soc. 22 (1886) 231; C.CHR. in Copel. Philip. J. Sc. 37 (1928) 411. — *Leptochilus modestus* C.CHR. Ind. Fil. (1906) 386. — *Campium modestum* COPEL. Brittonia 1 (1931) 76, f. 1. — *B. modesta* CHING in C. Chr. Ind. Fil. Suppl. 3 (1934) 49.

*Gymnopteris inconstans* COPEL. in Perk. Fragm. Fl. Philip. (1905) 177; Polyp. Philip. (1905) 43. —

*Leptochilus inconstans* CHRIST, Bull. Herb. Boiss. II, 6 (1906) 1005. — *Leptochilus heteroclitus* (PRESL) C. CHR. var. *inconstans* CHRIST, Philip. J. Sc. 2 (1907) Bot. 160. — *B. inconstans* CHING in C. Chr. Ind. Fil. Suppl. 3 (1934) 48.

*Leptochilus heteroclitus* (PRESL) C. CHR. var. *eurybasis* CHRIST, Philip. J. Sc. 2 (1907) Bot. 159. — *Campium heteroclitum* (PRESL) COPEL. var. *eurybasis* COPEL. Philip. J. Sc. 37 (1928) 361.

*Leptochilus heteroclitus* (PRESL) C. CHR. var. *foxworthyi* CHRIST, Philip. J. Sc. 2 (1907) Bot. 160.

*Leptochilus sumatranus* V. A. V. R. Bull. Jard. Bot. Btzig II, 23 (1916) 15, pl. 2: f. 1a-c; Handb. Mal. Ferns, Suppl. 1 (1917) 436; *ibid.* Corrections (1917) 60.

*Campium nigrum* COPEL. Philip. J. Sc. 37 (1928) 361, f. 14, pl. 10. — *B. nigra* CHING in C. Chr. Ind. Fil. Suppl. 3 (1934) 49.

*Campium pseudoscalpturatum* COPEL. Philip. J. Sc. 37 (1928) 363, f. 16, pl. 11. — *B. pseudoscalpturata* CHING in C. Chr. Ind. Fil. Suppl. 3 (1934) 49; COPEL. Fern Fl. Philip. (1960) 261.

*Campium foxworthyi* COPEL. Philip. J. Sc. 37 (1928) 364, f. 17, pl. 12. — *B. foxworthyi* CHING in C. Chr. Ind. Fil. Suppl. 3 (1934) 48; COPEL. Fern Fl. Philip. (1960) 258.

*Campium tenuissimum* COPEL. Philip. J. Sc. 37 (1928) 364, f. 18, pl. 13. — *B. tenuissima* COPEL. Fern Fl. Philip. (1960) 259.

*Leptochilus simplicifolius* HOLTUM, Gard. Bull. S. S. 4 (1929) 409. — *B. simplicifolia* CHING in C. Chr. Ind. Fil. Suppl. 3 (1934) 50; HOLTUM, Ferns Malaya (1954) 464, f. 272.

*Campium membranaceum* COPEL. Philip. J. Sc. 40 (1929) 307, pl. 7. — *B. membranacea* C. CHR. Ind. Fil. Suppl. 3 (1934) 198; COPEL. Fern Fl. Philip. (1960) 261.

*B. edanyoi* COPEL. Philip. J. Sc. 81 (1952) 22, pl. 15; Fern Fl. Philip. (1960) 258.

*Edanyoa difformis* COPEL. Philip. J. Sc. 81 (1952) 22, pl. 17; Fern Fl. Philip. (1960) 265. — Fig. 25d, 31a-g.

*Sterile fronds* simple or pinnate, 15–100 cm long. *Pinnate fronds* 25–100 cm long; lamina index of non-flagelloid leaves 1–5, that of flagelloid leaves sometimes more, 10–> 75 by 5–30 cm, terminal segment to > 75 cm long, herbaceous, usually greenish, sometimes purplish; pinnae 2–10(–15), index 2–5(–7), 1–26 by 0.7–6.5 cm, base attenuate to truncate, margin usually  $\pm$  entire, sometimes sinuate or sinuate-serrate or finely repand without teeth of spines; *terminal segment* usually  $\pm$  conform to the pinnae, sometimes flagelloid; *venation pattern*: veins anastomosing into a  $\pm$  regular pattern of variously large areoles, see fig. 31g. *Simple fronds* 15–45 cm long; lamina index 3–7(–17), 10–30 by (1–)2–7 cm, otherwise similar to the terminal segment of pinnate fronds. — *Fertile fronds* 14–75 cm long. *Pinnate fronds* 30–75 cm long; lamina index 1–4, pinnae index 2–7, 1–13 by 0.5–2.5(–4) cm. *Simple fronds* 14–40 (–> 45) cm long; lamina index 3–10, 4–13 by 0.5–2 cm. *Sporangia* inserted all over the lower surface. Spores with a smooth, cristate or cristate-undulate perispore. — Chromosomes  $n = 41$ ,  $2n = 82$ ,  $c. 123$ .

Distr. E. India to S. Japan, Formosa, and Indo-China; in *Malesia*: throughout, except for the

Lesser Sunda Is.; also in Micronesia (Caroline Is.) and Melanesia (Solomon Is.).

Ecol. On rocks, in soil or on bases of trees in moist places in rain-forest (often near streams), sometimes rheophytic, 0–1500(–1750) m.

Note. The morphological variation is outstanding. Throughout its area forms with simple fronds occur, e.g. *B. simplicifolia* from higher elevations in Malaya. In the Philippines several distinct vegetatively propagating dwarfs occur, e.g. *Edanyoa difformis* and *B. cuspidata*. Autopolloidisation and hybridisation are common. Field studies are necessary to further unravel this aggregate.

**8. *Bolbitis sinuata*** (PRESL) HENNIPMAN, Blumea 18 (1970) 148; Leid. Bot. Ser. 2 (1977) 232, f. 61, 62. — *Polypodium ? sinuatum* PRESL, Rel. Haenk. 1 (1825) 21.

*Acrostichum diversifolium* BL. En. Pl. Jav. (1828) 103; Fl. Jav. Fil. (1829) 36, pl. 12. — *B. diversifolia* SCHOTT, Gen. Fil. (1835) ad t. 13; BACKER & POSTH. Varenfl. Java (1939) 84; HOLTUM, Ferns Malaya (1954) 465; COPEL. Fern Fl. Philip. (1960) 258. — *Leptochilus diversifolius* C. CHR. Ind. Fil. (1906) 385; CHRIST, Philip. J. Sc. 2 (1907) Bot. 160, *quoad nomen solum*; V. A. V. R. Handb. Mal. Ferns (1908) 740. — *Campium diversifolium* COPEL. Philip. J. Sc. 37 (1928) 362, f. 15; BACKER & POSTH. Nat. Tijd. N. I. 93 (1933) 164.

*Gymnopteris subsimplex* FÉE, Hist. Acrost. (1845) 83, pl. 40: f. 3. — *Campium subsimplex* COPEL. Philip. J. Sc. 37 (1928) 356, f. 11, pl. 8; BACKER & POSTH. Nat. Tijd. N. I. 93 (1933) 159. — *B. subsimplex* CHING in C. Chr. Ind. Fil. Suppl. 3 (1934) 50; BACKER & POSTH. Varenfl. Java (1939) 81; COPEL. Fern Fl. Philip. (1960) 265.

[*Gymnopteris subrepanda* J. SMITH, Hook. J. Bot. 3 (1841) 403, *nomen*.] — *Poecilopteris subrepanda* PRESL, Epim. Bot. (1851) 171.

*Anapausia zollingeri* PRESL, Epim. Bot. (1851) 187. — *Leptochilus zollingeri* FÉE, Gen. Polyp. (1852) 55; V. A. V. R. Handb. Mal. Ferns (1908) 742, p.p.; *ibid.* Suppl. (1917) 436. — *Acrostichum zollingeri* KUNZE, Bot. Zeit. (1864) 419; COPEL. Philip. J. Sc. 37 (1928) 357. — *Chrysodium zollingeri* KUHN, Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 293.

*Acrostichum variabile* HOOK. var. *rasamalae* RACIB. Pterid. Fl. Btzig (1898) 50.

*Leptochilus hydrophyllum* COPEL. Philip. J. Sc. 1 (1906) Suppl. 146. — *Campium hydrophyllum* COPEL. Philip. J. Sc. 37 (1928) 358, f. 12, pl. 9. — *B. hydrophylla* CHING in C. Chr. Ind. Fil. Suppl. 3 (1934) 48.

*Leptochilus malaccensis* C. CHR. Gard. Bull. S. S. 4 (1929) 394. — *B. malaccensis* CHING in C. Chr. Ind. Fil. Suppl. 3 (1934) 49; HOLTUM, Ferns Malaya (1954) 470.

*B. nitens* HOLTUM, Kew Bull. 13 (1958) 453; Ferns Malaya ed. 2 (1966) 635. — Fig. 27j.

*Sterile fronds* simple or pinnate, (8–)20–100 cm long. *Pinnate fronds* 35–100 cm long; lamina index 1–3, 25–60 by 8–40 cm, terminal segment 15–50 cm long, usually (sub)coriaceous, sometimes sub-carnose, olivaceous or brownish; pinnae 2–11, index 3–10(–20), 5–35 by (0.5–)1–7 cm, base attenuate to truncate, margin entire or irregularly sinuate especially in the lower half, without teeth or spines throughout; *terminal segment*  $\pm$  conform

to the central pinnae; *venation pattern*: veins anastomosing into a regular network of variously sized areoles, see fig. 27j. *Simple fronds* (8-)20-75 cm long; lamina index 3-10, (7-)20-60 by (1-)3-15 cm, otherwise like the terminal segment of pinnate fronds. — *Fertile fronds* (8-)20-90 cm long. *Pinnate fronds* 30-90 cm long; lamina index 1-4, pinnae index 4-10(-16), 5-17 by (0.5-)0.7-3 cm. *Simple fronds* (8-)20-60 cm long; lamina index 5-18, (4-)8-35 by (0.3-)0.5-4 cm. *Sporangia* inserted all over the lower surface. Spores with a smooth cristate perispore. — Chromosomes  $n = 41$ ,  $2n = 122 + \text{fragm.}$

Distr. India (Nicobar Is.) and Peninsular Thailand; in *Malesia*: Sumatra, Malay Peninsula, W. Java, Borneo, Philippines, New Guinea (in W. and NE. each one collection). Fig. 32.

Ecol. Terrestrial and low-epiphytic in evergreen forest, 0-1200(-1800) m.

Note. In the Malay Peninsula HOLTUM recognized two quite distinct forms, *B. malaccensis* and *B. nitens*.

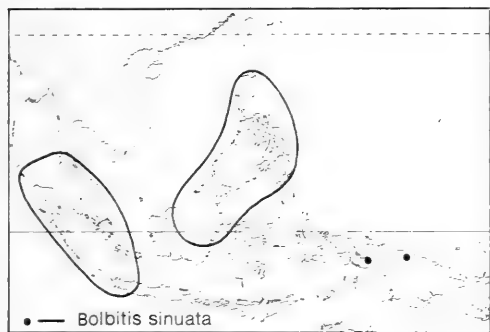


Fig. 32. Range of *Bolbitis sinuata* (PRESL) HENNIPMAN.

#### 4. Series Quoyanae

HENNIPMAN, Leid. Bot. Ser. 2 (1977) 250.

Sterile fronds usually pinnate, rarely simple; petiole with 3-16 vascular bundles; lamina with one subterminal bulbil; pinnae up to 52, the margin with or without spines; terminal segment triangular; *venation pattern*: veins regularly reticulate, areoles angulate,  $\pm$  isodiametric or elongate, decreasing in size towards the margin. Spores with a smooth, cristate or cristate-undulate perispore. — Chromosomes  $n = 41$ ,  $2n = 82$ , 123.

Distr. *E. Malesia*, Pacific, Japan (Bonin Is.).

9. *Bolbitis quoyana* (GAUDICH.) CHING in C.Ch. Ind. Fil. Suppl. 3 (1934) 49; BACKER & POSTH. Varenfl. Java (1939) 81, p.p.; COPEL. Fern Fl. Philip. (1960) 264; HENNIPMAN, Leid. Bot. Ser. 2 (1977) 250, f. 69, 70. — *Acrostichum quoyanum* GAUDICH. in Freyc. Voy. Uranie (1827) 306, pl. 3; HOOK. Sp. Fil. 5 (1864) 259. — *Gymnopteris repanda* (BL.) CHRIST var. *quoyana* (GAUDICH.) DIELS in K.Sch. & Laut. Fl. Schutzgeb. (1900) 117. — *Leptochilus cuspidatus* (PRESL) C.Ch. var. *quoyanus* C.Ch. ex V.A.V.R. Handb. Mal. Ferns (1908) 742, p.p.; BRAUSE, Bot. Jahrb. 56 (1920) 117. — *Campium quoyanum* COPEL. Philip. J. Sc. 37

(1928) 366, f. 20a, p.p.; BACKER & POSTH. Nat. Tijd. N. I. 93 (1933) 161, p.p.

*Heteroneuron naumannii* KUHN, Forsch. Reise Gazelle 4, Farne (1889) 5, pl. 1. — *Gymnopteris naumannii* DIELS in K.Sch. & Laut. Fl. Schutzgeb. (1900) 117. — *Leptochilus naumannii* C.Ch. Ind. Fil. (1906) 386; V.A.V.R. Handb. Mal. Ferns (1908) 742; BRAUSE, Bot. Jahrb. 56 (1920) 118. — *B. naumannii* CHING in C.Ch. Ind. Fil. Suppl. 3 (1934) 49.

*Leptochilus cuspidatus* (PRESL) C.Ch. var. *marginalis* ROSENST. in Fedde, Rep. 9 (1911) 426; V.A.V.R. Handb. Mal. Ferns Suppl. (1917) 435; BRAUSE, Bot. Jahrb. 56 (1920) 117.

*Aspidium novo-pommeranicum* BRAUSE ex RECH. Denkschr. K. Ak. Wiss. M.-N. Kl. Wien 89 (1914) 471, pl. 3: f. 8b.

*Campium validum* COPEL. Philip. J. Sc. 37 (1928) 369, f. 22, pl. 15.

*Campium parvum* COPEL. Philip. J. Sc. 37 (1928) 375, f. 28, pl. 21. — *B. parva* CHING in C.Ch. Ind. Fil. Suppl. 3 (1934) 49.

*Campium enorme* COPEL. Philip. J. Sc. 40 (1929) 307, pl. 8. — *B. enormis* C.Ch. Ind. Fil. Suppl. 3 (1934) 197; COPEL. Fern Fl. Philip. (1960) 264.

*Campium viviparum* KJELLB. in C.Ch. Bot. Jahrb. 66 (1933) 50. — *B. vivipara* C.Ch. Ind. Fil. Suppl. 3 (1934) 51.

*Stenosemia dimorpha* COPEL. Philip. J. Sc. 84 (1955) 161, pl. 1.

[*Cyrtogonium laciniatum* J. SMITH, Hook. J. Bot. 3 (1841) 403, nomen.] — Fig. 31h-k.

Sterile fronds pinnate, up to 130 cm long; lamina index 1-3(-4), up to 80 by 40 cm, terminal segment 9-26 cm long, herbaceous to subcoriaceous, green or brown (or blackish); pinnae 13-52, index 2-7, 7-22 by 1.3-3.5(-4.5) cm, base symmetrical, (narrowly to) broadly cuneate to cordate, margin usually lobed  $\frac{1}{3}$ - $\frac{2}{3}$  towards the costa, sometimes either  $\pm$  entire or lobed to  $\frac{4}{5}$  towards the costa, with a usually rather inconspicuous spine in the sinuses, apex acute to acuminate, lobes close together to spaced, straight or subfalcate, margin entire or crenate-serrate; terminal segment narrowly triangular, shorter than the remaining part of the lamina; *venation pattern*: veins forming a regular network, areoles angulate isodiametric or elongate decreasing in size towards the margin, see fig. 31j-k. *Fertile fronds* up to 120 cm long; lamina index 3-6, pinnae index 5-15, 3-15 by 0.4-1.7 cm. *Sporangia* usually inserted all over the lower surface, sometimes situated along the margin only, the arrangement usually acrostichoid, sometimes  $\pm$  pteridoid. Spores with a smooth cristate perispore. — Chromosomes  $n = 41$ ,  $2n = 82$ , 123.

Distr. Queensland, Polynesia (Samoa, Fiji), Melanesia (Solomons), Micronesia (Bonin Is.); in *Malesia*: New Guinea (common, also in the Bismarcks), Moluccas (P. Pisang, Halmahera, Ternate, Morotai), Philippines, Celebes, Central & West Java. Fig. 33.

Ecol. On rocks and in soil in rain-forest, mostly near streams; several times reported from limestone; 0-1200(-1700) m.

Note. The species has been confused with *B. repanda*. It is closest to *B. rivularis*, its coriaceous counterpart (and also showing a tendency to dwarfing), and to *B. taylorii*, an endemic from Queensland.

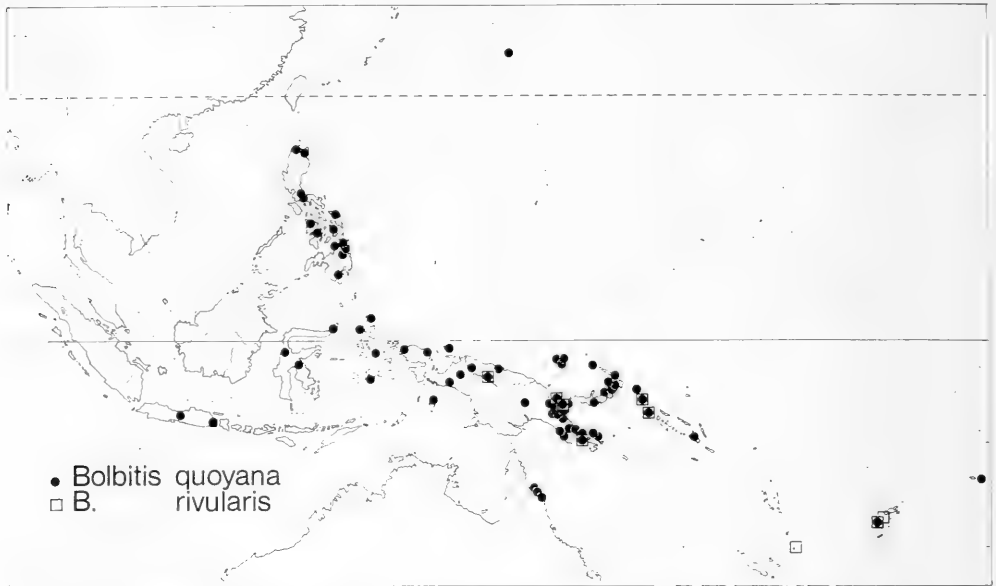


Fig. 33. Range of *Bolbitis quoyana* (GAUDICH.) CHING and *B. rivularis* (BRACKENR.) CHING.

**10. *Bolbitis rivularis*** (BRACKENR.) CHING in C.Chr. Ind. Fil. Suppl. 3 (1934) 50; BACKER & POSTH. Varenfl. Java (1939) 82 ('*B. ? rivulare*'); HENNIPMAN, Leid. Bot. Ser. 2 (1977) 255, f. 70, 71. — *Cyrtogonium rivulare* BRACKENR. in Wilkes, U.S. Expl. Exp. 16 (1854) 85, pl. 11: f. 2. — *Leptochilus rivularis* C.CHR. Ind. Fil. (1906) 387. — *Campium rivulare* COPEL. Philip. J. Sc. 37 (1928) 373, f. 27, pl. 20; BACKER & POSTH. Nat. Tijds. N. I. 93 (1933) 161.

*Campium kajewskii* COPEL. Philip. J. Sc. 60 (1936) 112, pl. 22.

*Sterile fronds* usually pinnate, rarely simple, 10–70 cm long. *Pinnate fronds* 10–70 cm long; lamina index 1–3(–5), 7–40 by 3–25 cm, terminal segment 5–30 cm long, fleshy-coriaceous, olivaceous to brownish; pinnae 2–11, index 1–5, 1.5–16 by 0.8–4.5 cm, base  $\pm$  symmetrical, cuneate to subcordate, margin  $\pm$  entire to lobed to  $1/3$ (– $2/3$ ) towards the costa, without or with but an inconspicuous tooth or spine in the sinuses; *terminal segment* triangular, as long as to longer than the remaining part of the lamina; *venation pattern*: veins forming a regular network of angulate, isodiametric or elongate areoles which decrease in size towards the margin. *Simple fronds* 15–30 cm long, lamina index 4–7, 12–23 by 2.5–4.5 cm, base cuneate to subcordate, margin  $\pm$  entire to lobed to  $2/3$  towards the costa, otherwise similar to the terminal segment of pinnate fronds. — *Fertile fronds* pinnate, 20–75 cm long; lamina index 1–4, pinnae index 1–6, 1.2–9 by 0.3–1.5 cm. *Sporangia* inserted all over the lower surface. Spores with a smooth cristate perispore. — Chromosomes  $n = 41$ .

Distr. Polynesia (Fiji), Melanesia (Solomons, New Hebrides); in Malesia: New Guinea (West: 2 collections; East). Fig. 33.

Ecol. Terrestrial and on rocks in moist places in rain-forest; several times reported to grow near or in streams, 0–2000 m.

Note. The species is not rarely found fertile with small leaves composed of a large terminal segment and two small pinnae. Dwarfs grow massed on rocks in rivers in New Guinea.

#### Species incertae sedis

**11. *Bolbitis novoguineensis*** HENNIPMAN, Leid. Bot. Ser. 2 (1977) 270, f. 74k–n. — Fig. 311.

*Sterile fronds* pinnate, 9–21 cm long; lamina index 3–5, 7–17 by 2–4 cm, terminal segment 1.5–4 cm long, firm-herbaceous (to subcoriaceous?), olivaceous, with a  $\pm$  terminal bulbil; rachis with a narrow wing throughout or in the upper half only; pinnae  $> 16$  to 30, index 1–3, 1–2.4 by 0.7–0.8 cm, base usually symmetrical, cuneate, sometimes somewhat asymmetrical, its basiscopic side cuneate, the acroscopic side either broadly attenuate or with a basal acroscopic lobe, margin (bi)crenate-serrate with distinct spines in the sinuses; *terminal segment* usually narrowly triangular, much shorter than the remaining part of the lamina, the basal half with few lobes, tapering towards the acute or short-flagelloid apex, sometimes the whole terminal segment flagelloid; *venation pattern*: veins usually forming a costal areole, sometimes locally free. *Fertile fronds* 15– $> 20$  cm long; lamina index  $c. 10$ , pinnae index 4–6, 0.6–0.8 by  $c. 0.2$  cm. *Sporangia* inserted all over the lower surface. Spores with a smooth cristate perispore.

Distr. Malesia: E. New Guinea (D'Entrecasteaux Is.), 3 collections.

Ecol. Creeping on rocky banks of streams in rain-forest, 250 and 900 m.

Note. A small thickening presumably representing a primordium of a bulbil is found terminally on the costae.

**12. *Bolbitis repanda* (BL.) SCHOTT, Gen. Fil. (1835) ad t. 13; HENNIPMAN, Leid. Bot. Ser. 2 (1977) 274, f. 78. — *Acrostichum repandum* BL. En. Pl. Jav. (1828) 104; Fl. Jav. Fil. (1829) 39, pl. 14, 15, p. p. — *Campium repandum* PRESL, Tent. Pterid. (1836) 239. — *Gymnopteris repanda* CHRIST, Farnkr. Erde (1897) 50, p. p.; DIELS in E. & P. Nat. Pfl. Fam. 1, 4 (1901) 201, p. p.; COPEL. Publ. Bur. Gov. Lab. 28 (1905) 43, p. p. — Fig. 27i.**

*Sterile fronds* pinnate, 35–100(–120) cm long; lamina index of non-flagelloid fronds 1–3, of flagelloid fronds up to 7, 15–70(–100) by 6–30 cm, terminal segment 8–60(–70) cm long, herbaceous-pergamenteraceous, green to blackish, with a (primordium of a) spherical subterminal bulbil; pinnae 8–20(–24), index (2–)3–6(–8), 4.5–22 by 1.5–4.5 cm, base  $\pm$  symmetrical, angustate to broadly cuneate, margin lobed  $1/4$ – $1/2$  towards the costa, usually with a distinct tooth in each sinus, lobes usually finely serrate-crenate, sometimes entire; the two lowermost pinnae  $\pm$  conform to the pinnae; *terminal segment* triangular; *venation pattern* irregular, veins forming areoles varying in shape and size, some of which with usually one, mostly excurrent included free vein, see fig. 27i. *Fertile fronds* 35–85 cm long; lamina index 2–5, pinnae index 3–9, 1.5–7 by 0.4–1.5(–2) cm. *Sporangia* inserted all over the lower surface. Spores with a smooth cristate-undulate perispore. — Chromosomes  $n = 82$ ,  $2n = c. 120$ .

Distr. Micronesia (one record from the Marianas); in *Malesia*: Philippines (Luzon, Mindanao), Borneo (Sabah, Sarawak), Celebes, Lesser Sunda Is. (Bali to Flores).

Ecol. Usually terrestrial, sometimes low-epiphytic, in forest, 125–1650 m.

Note. Presumably of hybrid origin. The irregular venation pattern shows considerable variation and includes all intermediates between a venation pattern as found in *B. sinensis* or *B. rhizophylla* (both ser. *Egenolfianae*) and one as found in *B. heteroclita* (ser. *Heteroclitae*).

### Hybrids

**H. 1. *Bolbitis*  $\times$  *arguta* (FÉE) CHING in C. Chr. Ind. Fil. Suppl. 3 (1934) 47; COPEL. Fern Fl. Philip. (1960) 263, p. p., p. spec.; HENNIPMAN, Leid. Bot. Ser. 2 (1977) 288, f. 83i, j. — *Heteroneuron argutum* FÉE, Hist. Acrost. (1845) 96, pl. 25: f. 2, p. p.; PRESL, Epim. Bot. (1851) 169. — *Campium argutum* COPEL. Philip. J. Sc. 37 (1928) 376, p. p.**

Fronds small, pinnate throughout or the basal part bipinnate, with a triangular terminal segment. *Sterile fronds*: lamina with a subterminal bulbil; pinnae irregularly and variously lobed, pinnae of one pair sometimes much different, odd pinnae present in part of the material. *Fertile fronds*: sporangia inserted all over the lower surface. Spores abnormal or sporangia with aborted spore-mother-cells.

Distr. *Malesia*: Philippines (Luzon), known from the type collection only.

Parentage. I have doubts whether this fern warrants a separate treatment as a hybrid; it may be close to *Edanyoa difformis* (= *B. heteroclita*).

**H. 2. *Bolbitis heteroclita*  $\times$  *rhizophylla* HENNIPMAN, Leid. Bot. Ser. 2 (1977) 291, f. 83l–o.**

*Sterile fronds* pinnate, with a subterminal bulbil; rachis with or without narrow wing; pinnae 16–24, index 3–5, 4.5–6 by 1.2–1.6 cm, base truncate to cuneate, margin usually  $\pm$  entire, sometimes irregularly and finely serrate or with a few incisions about halfway towards the costa, with distinct spines; *terminal segment* triangular, deeply lobed near the base; *venation pattern* irregular, veins forming a costal areole (rarely lacking), sometimes also one or a few smaller distal areoles. *Fertile fronds*: pinnae index 2–5, 1.6–4 by 0.6–0.8 cm. *Sporangia* inserted mainly on the veins. Spores abnormal, or with aborted spore-mother-cells. — Chromosomes  $2n = 82$ ; at meiosis univalents only.

Distr. *Malesia*: Philippines (Luzon, Mt Maquililing, 2 collections).

Ecol. A shady place in forest, at 350–400 m.

**H. 3. *Bolbitis*  $\times$  *singaporensis* HOLTUM, Gard. Bull. S. S. 11 (1947) 271; Ferns Malaya (1954) 467, f. 274; HENNIPMAN, Leid. Bot. Ser. 2 (1977) 296, f. 85a–d.**

*B. quoyana* auct. non (GAUDICH.) C. CHR.: HOLTUM, Gard. Bull. S. S. 9 (1937) 122. — Fig. 27n.

*Sterile fronds* pinnate, 35–70 cm long; lamina index 1–3, 22–45 by 10–25 cm, terminal segment 10–19 cm long, firm-herbaceous, bright green to olivaceous, with a subterminal bulbil; rachis not winged; pinnae 14–27, index 3–5, 5.5–12.5 by 1.5–3 cm, base varying from  $\pm$  symmetrical, subcordate, cuneate or angustate, to (strongly) oblique with its acroscopic side much better developed and provided with a distinct basal acroscopic lobe (or auricle), margin entire to lobed to  $1/4$ –( $1/4$ ) towards the costa, with a more or less distinct spine in (some of) the sinuses; *terminal segment* triangular; *venation pattern* very irregular: veins forming a costal areole (rarely lacking), with or without few to several smaller distal areoles varying in size and shape, the areoles with or without usually one excurrent included free vein, see fig. 27n. *Fertile fronds* 50–70 cm long; pinnae index 4–8, 2–6.5 by 0.4–1.2 cm. *Sporangia* inserted mainly on the veins. Spores abnormal, or sporangia with aborted spore-mother-cells. — Chromosomes  $2n = 82$ ; at meiosis univalents only.

Distr. *Malesia*: Malay Peninsula (Singapore, Fern Valley on Bt Timah).

Ecol. On granite rocks in stream-bed, in the shade of primitive forest.

Parentage. MANTON (in Holtum, 1954) correctly suggested this to be a hybrid between *Egenolfia appendiculata* (= *B. appendiculata* ssp. *appendiculata*) and *B. diversifolia* (= *B. sinuata*). These two species and the hybrid grow intermingled in the Fern Valley on Bt Timah.

**H. 4. *Bolbitis*  $\times$  *sinuosa* (FÉE) COPEL. Fern Fl. Philip. (1960) 262; HENNIPMAN, Leid. Bot. Ser. 2 (1977) 298, f. 85e–p. — *Heteroneuron sinuosum* FÉE, Hist. Acrost. (1845) 95; COPEL. Philip. J. Sc. 37 (1928) 368, f. 21.**

*B.  $\times$  foxii* COPEL. Philip. J. Sc. 81 (1952) 22; Fern Fl. Philip. (1960) 263. — Fig. 27m.

Distr. *Malesia*: Philippines (Luzon, Mindanao, Central Polillo).

Parentage. *B. quoyana* and possibly *B. rhizophylla* or *B. heteroclita*.

Two nothomorphs are distinguished.

**a. nm. sinuosa** HENNIPMAN, Leid. Bot. Ser. 2 (1977) 299, f. 85e, f.

*Sterile fronds* pinnate, up to 50 cm long; lamina index 1–2, 16–32 by 10–18 cm, terminal segment 8–12 cm long, herbaceous, dark olivaceous or brown, with or without a spherical subterminal bulbil; pinnae 13–20, index 5–7, 7.5–12 by 1.1–1.8 cm, base symmetrical, narrowly cuneate, margin shallowly and oblique lobed or finely crenate-serrate, with small teeth in the sinuses; *terminal segment* triangular; *venation pattern*: veins forming a costal areole and several smaller distal ones, the areoles without included free veins. *Fertile fronds*: pinnae c. 5 by 0.7–0.9 cm. *Sporangia* inserted all over the lower surface. Spores abnormal or sporangia with aborted spore-mother-cells.

Distr. *Malesia*: Philippines (Luzon, 3 localities).

**b. nm. foxii** (COPEL.) HENNIPMAN, Leid. Bot. Ser. 2 (1977) 299, f. 85g–p. — *B. × foxii* COPEL. Philip. J. Sc. 81 (1952) 22.

If compared with *nm. sinuosa* the plants are of the same size or smaller, with smaller and generally also narrower pinnae with a somewhat simpler venation pattern, see fig. 27m. — Chromosomes  $2n = c. 80$ .

Distr. *Malesia*: Philippines (3 collections from Polillo I., Luzon, and Mindanao).

#### Hybridae incertae sedis

**H. 5. Leptochilus × trifidus** v.A.v.R. Bull. Dép. Agr. Ind. Néerl. 18 (1908) 26; HENNIPMAN, Leid. Bot. Ser. 2 (1977) 300, f. 85q–w.

*Hemigramma latifolia* auct. non COPEL.: COPEL. Philip. J. Sc. 37 (1928) 404, p.p. — **Fig. 27l.**

*Sterile fronds* simple, either entire or trifid, 30–60 cm long, firm-herbaceous to subcoriaceous, brownish, with a small but conspicuous subterminal bulbil, base narrowly cuneate or angustate, gradually or abruptly decurrent on the petiole, margin entire or slightly sinuate; *venation pattern* rather irregular, see fig. 27l. *Fertile fronds* 25–50 cm long. *Sporangia* inserted all over the lower surface. Spores usually shrivelled, normally shaped spores with a smooth, (imperfectly developed) cristate-undulate or cristate perispore.

Distr. *Malesia*: Sumatra (3 localities in West Coast, East Coast, and Bencoolen).

Ecol. Forest; reported from rocks either in streams or on stream-banks, (one record) 450–500 m.

Parentage. *B. sinuata* and possibly *Leptochilus decurrens*. A very interesting hybrid which needs experimental study.

#### Species dubiae

**D. 1. Bolbitis interlineata** (COPEL.) CHING in C.Ch. Ind. Fil. Suppl. 3 (1934) 48; ITO, J. Jap. Bot. 14 (1938) 439, *quoad nomen solum*; HENNIPMAN, Leid. Bot. Ser. 2 (1977) 306, f. 86g, h. — *Campium interlineatum* COPEL. Philip. J. Sc. 37 (1928) 370, f. 24, pl. 17. — **Fig. 27k.**

*Sterile fronds* pinnate, 60–75 cm long; lamina index 1–2, 30–40 by 20–24 cm, terminal segment 12–20 cm long, herbaceous, with a spherical subterminal bulbil; pinnae 8–16, index 3–5, 13.5–15 by 3–4 cm, base either ± symmetrical, broadly cuneate to subcordate, or asymmetrical with its basicopic side longer and/or wider than its acroscopic side, margin entire or (in part) slightly sinuate; *terminal segment* ± conform to the pinnae or triangular with 1–2 basal lobes; *venation pattern* very intricate, reminiscent of that of *B. heteroclita* but part of the areoles with usually one excurrent included free vein, see fig. 27k. *Fertile fronds* 60–85 cm long; lamina index 2–4, pinnae index 5–8, 5–6 by 0.7–1 cm. *Sporangia* all over the lower surface. Spores with a smooth cristate perispore.

Distr. *Malesia*: Borneo (Sarawak: Bungo Range, Mt Matang, and Mt Penrissen).

Ecol. Forest; on rocks in streams, 300–690 m.

Note. Possibly of hybrid origin and related to *B. heteroclita* (venation pattern!) and to either *B. scalpturata* or *B. repanda*.

**D. 2. Leptochilus stolonifer** CHRIST, Bull. Herb. Boiss. II, 6 (1906) 1004; v.A.v.R. Handb. Mal. Ferns (1908) 739.

Distr. *Malesia*: Philippines (Angilog), type only.

Note. Possibly synonymous with *B. heteroclita* but the venation pattern as given by CHRIST is deviating. Type not traced.

#### Excluded

*Bolbitis ovata* (COPEL.) CHING in C.Ch. Ind. Fil. Suppl. 3 (1934) 49. — *Leptochilus ovatus* COPEL. Philip. J. Sc. 9 (1914) Bot. 229. — *Campium ovatum* COPEL. Philip. J. Sc. 28 (1937) 354, f. 9, pl. 6. — *Paraleptochilus ovatus* COPEL. Gen. Fil. (1947) 198. — Type: C. J. BROOKS 155 S, Sumatra, Bencoolen, Lebong Tandai, ii-1913 (iso in BM) = *Colysis cf. pedunculata* (HOOK. & GREV.) CHING.

*Bolbitis subcrenata* (HOOK. & GREV.) CHING; HENNIPMAN, Leid. Bot. Ser. 2 (1977) 176, f. 46, 47.

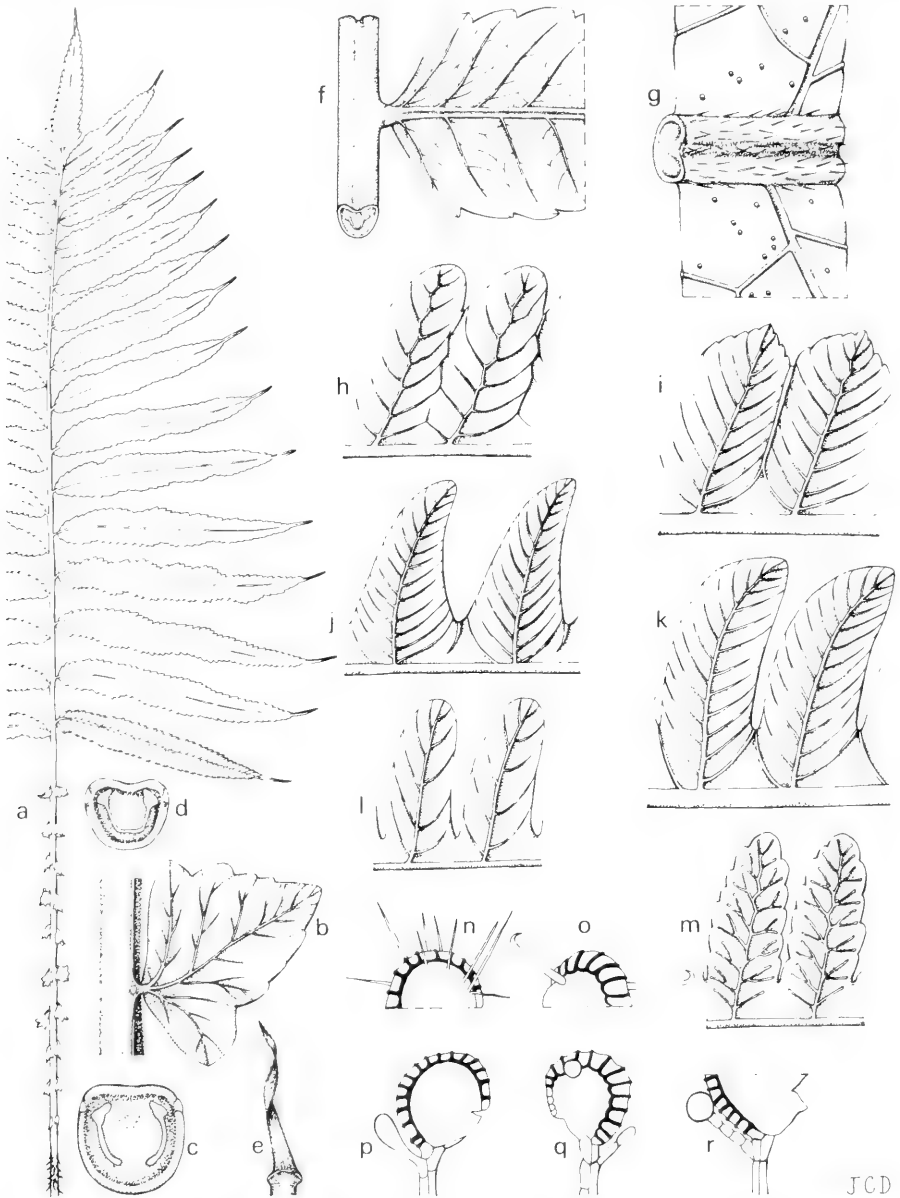
BACKER & POSTHUMUS (Varenf. Java, 1939, 80; Nat. Tijd. N. I. 93, 1933, 158, *pro Campium subcrenatum*) reported this fern from Java. The material traced belongs to *B. subcrenata* var. *prolifera* (endemic in Ceylon) and is presumably cultivated.

## THELYPTERIDACEAE (R. E. Holttum, Kew)

CHING, Sunyatsenia 5 (1940) 237–240, *excl. Hypodematium* KUNZE & *Parapolystichum* CHING; Acta Phytotax. Sinica 8 (1963) 289–335, *excl. Hypodematium* KUNZE; HOLTTUM, J. Linn. Soc. Bot. 53 (1947) 130; Blumea 19 (1971) 17–52; K. IWATS. Mem. Coll. Sci. Univ. Kyoto B, 30 (1929) 21–51; 31 (1964) 1–40, (1965) 125–197; PICHI SERMOLLI, Webbia 24 (1970) 709 (first Latin description). — **Fig. 1–20.**

*Caudex* erect, short-creeping or long-creeping, rarely scandent; vascular structure in all cases a radially symmetrical dictyostele; scales usually thin, not peltate, in almost all cases bearing both marginal and superficial unicellular hairs which are either acicular or glandular. *Vascular strands* at base of stipe 2, linear in section (rarely with an additional pair of small ones), uniting upwards to a U-shape; a linear aerophore with stomata continuous along each side of stipe and rachis. *Fronds* usually pinnate with crenate or lobed pinnae, in a few cases simple or bipinnate, never with basiscopically enlarged basal pinnae; apical lamina usually triangular and lobed, grading into upper pinnae, in some cases pinna-like; lower pinnae in many cases gradually much reduced or with abrupt transition to a series of small rudiments; a small *aerophore*, sometimes swollen or elongate, present at the base of each pinna; a translucent membrane present in the base of each sinus between adjacent pinna-lobes; *venation* in each pinna consisting of a costa bearing costules, each costule bearing pinnately-arranged veins in a pinna-lobe; veins free in deeply lobed pinnae, or basal veins in adjacent lobes anastomosing to form an excurrent vein, which may be joined by other veins, terminating at the base of a sinus-membrane, successive veins passing to the sides of the sinus-membrane where this is elongate. *Indument*: scales always present at base of stipe, gradually smaller upwards, minute (often consisting of a single row of cells) on the distal parts of fronds, often nearly all caducous; adaxial surface of rachis and costae always bearing antrorsely curved acicular unicellular hairs, in a few cases also septate acicular hairs; abaxial surface of rachis and costae usually bearing a different indument consisting of more slender unicellular acicular and/or glandular hairs or sessile glands of various forms (forked hairs in *Ampelopteris* only); surface of lamina between veins either quite glabrous or more often with a distinctive complement of hairs and glands different adaxially and abaxially. *Sori* borne on abaxial surface of veins, orbicular or sometimes elongate, indusiate or not; indusia reniform, glabrous or bearing hairs and/or glands, in some cases very small, athyrioid in some species of *Coryphopteris*; *sporangia* sometimes bearing glands or short acicular hairs (setae) near annulus, often with a hair of distinctive form on the sporangium-stalk; *spores* in almost all cases monolete, with perispore of varied form, in *Trigonospora* trilete. *Gametophyte* in all cases symmetrical-cordate, with unicellular chlorophyllous hairs on all parts, these hairs with  $\pm$  swollen rounded tips which become wax-encrusted; in most cases, usually as a late development, unicellular acicular hairs, comparable with those on the sporophyte, may occur; other types of hair may be distinctive of some genera.





JCD

Fig. 1. *Sphaerostephanos penniger* (HOOK.) HOLTUM. a. Whole frond,  $\times \frac{1}{4}$ ; b. a reduced pinna showing linear and round aerophores,  $\times 2$ ; c. CS base of stipe,  $\times 3$ ; d. CS rachis,  $\times 3$ ; e. scale,  $\times 6$ ; f. rachis and base of pinna, upper surface,  $\times 12$ ; g. part of pinna, upper surface, showing unicellular hairs and glands,  $\times 12$ . — Venation patterns in relation to sinus-membrane: h. *Sphaerostephanos penniger* (HOOK.) HOLTUM,  $\times 2$ ; i. *Christella arida* (D. DON) HOLTUM,  $\times 6$ ; j. *Plesioneuron fulgens* (BRAUSE) HOLTUM,  $\times 3$ ; k. *Mesophlebion crassifolium* (BL.) HOLTUM,  $\times 4$ ; l. *Coryphopteris viscosa* (BAK.) HOLTUM,  $\times 4$ ; m. *Metathelypteris dayi* (BEDD.) HOLTUM,  $\times 3$ . — Sporangia,  $\times 33$ : n. *Pronephrium repandum* (FÉE) HOLTUM; o. *P. rubicundum* (v.A.V.R.) HOLTUM; p. *Christella dentata* (FORSSK.) BROWNSEY & JERMY; q. *Sphaerostephanos heterocarpus* (BL.) HOLTUM; r. *Cyclosorus interruptus* (WILLD.) H. ITO.



**Distribution.** Throughout the tropics, especially in wetter areas; species few in temperate regions (5 in Europe), almost 1000 in all. The majority are terrestrial ferns of forest, but a few (especially in *Christella* and *Macrothelypteris*) occur in open places only, and a few (*Cyclosorus*, *Thelypteris*) in open swamps; some are adapted to grow on rocks by streams; very few are scandent; a few are casually epiphytic.

**Fossils.** Fossil ferns with veins anastomosing as in this family have been found in Lower Tertiary strata in both Europe and America, but in the absence of information concerning scales, hairs, glands and spores the affinity of such fossils to any existing groups cannot be definitely assessed; the oldest fossil which probably belongs to this family is *Aspidistes thomasi* HARRIS (Yorkshire Jurassic Flora I, 1951, 181) which has bipinnate or tripinnate fronds with free veins, abundant superficial glands much as in *Coryphopteris* and trilete spores resembling those of *Trigonospora*.

**Vegetative morphology.** A combination of two characters is distinctive of the family: the arrangement of vascular strands in the stipe (Fig. 1c-d) and the presence of unicellular acicular hairs on the adaxial surface of rachis and costae (Fig. 1g). The only other fern with this combination is *Hypodematum*, which differs greatly in frond-form and in scales. Also distinctive of *Thelypteridaceae* is the frond-form of most species: simply pinnate fronds with most pinnae almost equal in length, each pinna symmetrical on either side of the costa with veins symmetrically arranged in the pinna-lobes. The venation in its relation to sinus-membranes is also unique among ferns.

Distinctions between species are provided by details of venation and of the distribution of hairs and glands (more rarely of scales) on the two surfaces, the abaxial surface in general providing the greater diversity. Maximum size of fronds is also distinctive in many cases, but often plants may be fertile at an immature size.

**Dimorphism.** In some species sterile fronds have much larger (both longer and broader) pinnae than fertile ones, and in such species transitional forms may occur. In other species there is some irregular dimorphism. In general, sterile fronds often have longer hairs than fertile ones on the lower surface, sometimes much longer ones.

In general the number of veins anastomosing is dependent on the depth of lobing of pinnae, but this situation is complicated by the relative length of the sinus-membrane (Fig. 1h-m). Where the membrane is very short and pinnae shallowly lobed, anastomosing veins from adjacent costules form a zig-zag excurrent vein and only one vein may end in contact with the membrane, but if the membrane is long (forming a prominent fold on the lower surface) only one pair of veins may be united, successive ones passing to the sides of the membrane as if to the edge of a pinna-lobe. These details need to be carefully observed. In rare cases a long membrane may be present with no veins actually united. In other cases (especially on *Pneumatopteris*) a vein passing to the side of a membrane may be continued to join with the vein next above it, thus forming a continuous vein on one side of the membrane and sometimes extending into the pinna-lobe. CHING and IWATSUKI both state that a character of *Abacopteris* FÉE (*Pronephrium* of the present work) is the absence of a sinus-membrane, but such a condition is not invariable even in pinnae which have almost entire margins.

The species with bipinnate fronds have all, or most, of the pinnules adnate to a pinna-rachis (Fig. 2h); this is a contrast to *Cyathea*, with which genus *Thelypteridaceae* have some features in common, and I suggest that it is a secondary development (see below on relationships with other groups). These bipinnate species (in *Macrothelypteris* and *Pseudophegopteris*) also have veins terminating within the margin (Fig. 1m) and adaxial surface of rachises and costae not grooved, both conditions shared by *Metathelypteris* and *Phegopteris*; in all other genera costae are grooved (Fig. 1f-g) and all free veins terminate at the margin.

In some species of several genera the aerophores at pinna-bases are swollen or elongate. CHRISTENSEN united several such tropical American species in a subgenus *Glaphyropteris*, and some species of Asia were also so placed by ITO in Nakai & Honda, Nov. Fl. Japonica, part 4 (1939), but CHING (1963) recognized that the species so named by ITO were neither closely related to each other nor to the American species of CHRISTENSEN.

In most species (apart from *Pronephrium*) the apical lamina of a frond is narrowly to

broadly triangular and  $\pm$  deeply lobed, with a gradual transition at its base to the upper pinnae. The distal part of such an apical lamina has veins arranged in its lobes as in the lobes of a pinna, but near the base there is a transition from lobes to pinnae, with a transition also in venation. This transition in venation (especially when the terminal lamina is long and narrow) sometimes results in a condition comparable to that of normal pinnae or pinnules of *Pleocnemia* (a genus allied to *Tectaria*). In a few cases this peculiar transitional type of venation also occurs above the base of the apical lamina, and such a case was made the basis of a genus *Haplodictyum* by PRESL; some later authors, including CHING, thought that this venation indicated a real relationship of *Haplodictyum* to *Tectaria*, but certainly the former is a true thelypteroid fern. A fossil from America has also been reported with venation of *Haplodictyum* type (*Goniopteris claiborniana* BERRY, Bull. Torr. Bot. Club 44, 1917, 331, t.22).

Much-reduced pinnae at the base of a frond, usually with an abrupt transition to normal pinnae, occur in the large genera *Sphaerostephanos* (Fig. 1a-b) and *Pneumatopteris*; such a condition is rare in American *Thelypteridaceae*, though in *Amauropelta* lower pinnae are in most cases gradually much reduced. In young living fronds such reduced pinnae are seen to have more or less swollen white aerophores at their bases; in some cases the aerophore is larger than the lamina of the reduced pinna. The number, shape, and spacing of reduced pinnae provide useful distinguishing characters, but unfortunately some dried specimens do not show them fully and in other cases the frond-base is quite lacking. Where very young fronds are covered with mucilage the aerophores are sufficiently elongate for their tips to be free from the mucilage. Swollen aerophores (rarely much elongate) occur also in some genera where basal pinnae are not reduced.

Sori, sporangia and spores. The position of sori on veins is characteristic in each species; in *Chingia* sori are always near costules but within most genera there is much variation. More or less elongate sori occur in several genera, especially in *Stegnogramma* (all species) and *Sphaerostephanos*, but within the latter genus the species with elongate sori do not form a natural group. In some species where indusia are normally very small they are sometimes quite lacking, but in general size and indument of indusia are characteristic. In *Coryphopteris* distal sori sometimes have athyroid indusia, basal ones rarely.

The form of sporangia and the presence of glands or hairs on them are always important diagnostically (Fig. 1n-r) but these characters are often unrecorded in original descriptions, even of recent publication. I have tried to obtain exact information from type specimens. In *Christella*, *Coryphopteris* and *Metathelypteris* there are neither glands nor hairs near the annulus (but see note under *Christella subpubescens*). Hooked hairs occur on sporangia in *Pronephrium* sect. *Grypothrix* (Fig. 1o) and in *Cyclogramma*. The sporangia of *Coryphopteris* are almost sessile but in most other members of the family they have slender stalks on some of which are hairs; the nature of these hairs is also distinctive (Fig. 1p-r) but I have not been able to report it for all species.

Spores of all species are covered with a perispore which may have many different external forms (see C. C. WOOD, J. Linn. Soc. Bot. 67, Suppl. I, 1973, 191-202, pl. 1-4); this has only been well observed since the introduction of the scanning electron microscope. The inner structure of spore-walls can only be seen by sectioning and has still been little investigated. LUGARDON has made sections of a representative set of spores; a report on this work will be published separately. It gives some support to the present arrangement but leaves many questions unanswered.

Gametophyte. Apart from the development in some species of acicular hairs, the general characters of gametophytes do not distinguish this family from others; the glandular hairs universally present occur also in other families. Reports have been published by L. R. ATKINSON on species of various genera in the Old World, summarizing also those of earlier authors (Phytomorphology 25, 1975, 38-54) and on *Chingia* (Fern Gaz. 11, 1975, 87-93). Gametophytes of *Mesophlebion crassifolium* have distinctive branched hairs and also spherical red glands resembling those on the stalks of sporangia of sporophytes. Gametophytes of *Chingia sakayensis* have distinctive multicellular hairs. Gametophytes of other genera show differences in the colour of glandular hairs or other less easily specified

characters. Gametophyte characters support the separation of the genera *Plesioneuron* and *Mesophlebion* which I formerly united (HOLTUM 1971), but in general do not offer much important evidence as to the separation of, or inter-relations between, genera, partly because few species in most genera (as here recognized) have been examined.

**Cytology.** The first reliable reports on chromosomes were by I. MANTON in her book of 1950. Subsequently many reports have been published, as summarized by LÖVE, LÖVE and PICHI SERMOLLI in their Cytotaxonomical Atlas of the Pteridophyta (1977). Haploid numbers range from 27 to 36; several species are tetraploid and of some both diploid and tetraploid forms have been reported, in the wide-ranging species *Macrothelypteris torresiana* tetraploid and hexaploid. Only a small proportion of species have so far been examined, so that generalizations cannot usefully be made. In all recorded cases species belonging to one genus, as here recognized, have the same chromosome number except that both  $n = 35$  and  $n = 36$  occur in the genus *Pseudocyclosorus* in India (there is only one Malesian species). Hybridization experiments have only been reported by MANTON and her co-workers in the genus *Christella* q.v. for details.

**Taxonomy.** The distinguishing characters of this family were not recognized until CHRISTENSEN's study of tropical American species in 1913 (see below); in the 19th century there was much confusion in the use of generic names which were based mainly on soral characters.

LINNAEUS placed the species known to him in *Polypodium* or *Acrostichum*; he did not use characters of indusia in distinguishing genera. The name *Thelypteris* was published by SCHMIDEL in 1763; it has been conserved against *Thelypteris* ADANSON (= *Pteris*) which may have been published earlier in the same year. In 1791 SCHREBER proposed the name *Meniscium* for a species from tropical America having elongate exindusiate sori resembling those of the Malesian species here named *Pronephrium triphyllum*, which was transferred to *Meniscium* by SWARTZ in 1801; other authors followed this assignment but CHRISTENSEN stated his belief that the Malesian and American species in question are not closely related; see further discussion under *Pronephrium*.

In 1800 ROTH published the name *Polystichum* for ferns with either peltate or reniform indusia; these included some *Thelypteridaceae* in addition to *Polystichum aculeatum* (generic type) and species of *Dryopteris* and *Gymnocarpium*. GAUDICHAUD later included some tropical *Thelypteridaceae* in *Polystichum*.

In 1801 SWARTZ published *Aspidium*, with almost the same diagnosis as *Polystichum* ROTH, and included in it, besides *Thelypteridaceae* of several genera here recognized, species now placed in *Tectaria*, *Oleandra*, *Nephrolepis*, *Didymochlaena*, *Polystichum*, *Dryopteris*, *Cystopteris* and *Athyrium*. Also in 1801 CAVANILLES published the name *Tectaria* with a single species (now recognized as type of a non-Thelypteroid genus) but he later included in it a mixture similar to that in *Aspidium* Sw. In 1803 MICHAUX published *Nephrodium*, which also included species of many genera now regarded as distinct; see below for confused later usage of this name.

In 1824 BORY published the name *Lastrea* for "la plus grande partie des Polypodes à feuilles bipinnatifides ou bipinnées", citing a few species only; he did not refer to *Aspidium* or *Nephrodium*, though the species he cited could have been placed in either. In 1833 LINK published *Cyclosorus* for the single species which he named *C. gongylodes*; this had previously been included in *Aspidium*, *Nephrodium* and *Polystichum*. BLUME in 1828 included all indusiate *Thelypteridaceae* in *Aspidium*, exindusiate ones in *Meniscium*, *Gymnogramme* and *Polypodium*; he established *Stegnogramma* for a species with elongate exindusiate sori and anastomosing veins.

SCHOTT's 'Genera Filicum', published in 1834, contained twenty beautifully engraved plates showing details of as many genera; these included a plate illustrating *Nephrodium* which showed for the first time with great exactness the unicellular acicular hairs characteristic of all *Thelypteridaceae* (also capitate hairs) and other details now considered significant; he also mentioned the vascular strands in the stipe. His description of the genus and list of species shows that he restricted it to thelypteroid ferns having anastomosing veins and round indusiate sori, none of which were in the original list published by MICHAUX (to

which he did not refer). SCHOTT also recognized *Thelypteris* SCHMIDEL as an allied genus with free veins.

In 1836 appeared PRESL's 'Tentamen Pteridographiae', containing a completely new system of fern genera. He adopted SCHOTT's definition of *Nephrodium* and included most free-veined thelypteroids in *Lastrea*. But in *Lastrea* he also placed species of *Dryopteris*, *Ctenitis* and several other genera now recognized. He retained exindusiate free-veined *Thelypteridaceae* in *Polypodium* sect. *Phegopteris* (with much admixture of non-thelypteroids), those with anastomosing veins of the *Nephrodium* pattern in *Goniopteris* and those with elongate sori in *Grammitis*. In 'Epimeliae Botanicae' (1851) PRESL proposed the new genera *Haplodictyum*, *Physematium*, *Proferea* and *Pronephrium* for thelypteroid ferns from the Philippines and Java.

W. J. HOOKER devoted the last twenty years of his life to producing 'Species Filicum' (five volumes, 1844–1864). He united all indusiate *Thelypteridaceae* in *Nephrodium*, and with them *Dryopteris*, *Ctenitis* and *Pleocnemia*; he followed PRESL in placing exindusiate species in *Polypodium*, but those with elongate sori in *Gymnogramme* and *Grammitis*.

Simultaneously with HOOKER's work, A. L. A. FÉE produced his 'Genera Filicum' (1852), in which his arrangement is more elaborate. He placed the majority of *Thelypteridaceae* in *Polypodiaceae*, tribe *Aspidieae*. Free-veined indusiate species, mixed with others now allocated to *Dryopteris* and *Ctenitis*, are placed in *Aspidium*; species with anastomosing veins and indusiate sori in *Nephrodium*, *Haplodictyum* and *Abacopteris*; species with round exindusiate sori in tribe *Polypodieae*, genera *Phegopteris* and *Goniopteris*; species with elongate sori in tribe *Menisceae* and tribe *Leptogrammeae* (with admixture of species now referred to very different groups).

G. METTENIUS, in his 'Fil. Hort. Bot. Lipsiensis' (1856) included both indusiate and exindusiate thelypteroids with free or anastomosing veins in his "tribe" *Aspidieae*, separating all exindusiate species as *Phegopteris*, the rest in *Aspidium*. In his monograph of *Phegopteris* and *Aspidium* (1858) he had many non-thelypteroid species in both genera; but in his descriptions he noted characters of hairs, glands and scales with much more care than any previous author except SCHOTT.

JOHN SMITH, who observed more than 1000 species of ferns as cultivated plants, published another classification in 'Historia Filicum' (1875) and in a long introduction commented on previous schemes. He placed almost all thelypteroids in his tribe *Phegopteridiae*, separating indusiate and exindusiate species (the former as *Lastrea* and *Nephrodium*) in much the same way as METTENIUS, but noting that indusia are sometimes very small or fugacious so that separating on this character was often doubtful. Among free-veined ferns named *Lastrea* he had representatives of other genera (as now recognized) but he subdivided *Lastrea* to show some of these differences, as METTENIUS had not done.

R. H. BEDDOME, studying ferns in the field in southern India from 1856 to 1882, used HOOKER'S classification but recognized some of its unsatisfactory features. In his Handbook (1883) and its Supplement (1892) he included also species of the Malay Peninsula, and owing to a lack of critical study of Malesian ferns he sometimes misidentified Indian species with those of Java.

Field work on ferns in Java was undertaken by M. RACIBORSKI in 1897–1898, and the results were published in 'Flore de Buitenzorg, I, Pteridophytes' (1898). This includes much previously unrecorded ecological observation. RACIBORSKI placed free-veined *Thelypteridaceae* in *Aspidium* (with species of *Dryopteris* and *Ctenitis*) and those with anastomosing veins in *Nephrodium*.

H. CHRIST in 1897 attempted a new survey of all ferns ('Die Farnkräuter der Erde'). He followed METTENIUS in placing almost all thelypteroid ferns in *Aspidium* and *Phegopteris*. Subsequently he adopted CHRISTENSEN's concept of *Dryopteris* (see below) and in 1907 his survey of *Dryopteris* in the Philippines was published; his work on the present family was uncritical.

L. DIELS compiled a summary of *Polypodiaceae* for Engler & Prantl's 'Natürlichen Pflanzenfamilien' (I, Abt. 4, 1899). He included all thelypteroid ferns in his tribe *Aspidieae*, almost all of them in *Nephrodium*, uniting indusiate and exindusiate species in one genus for

the first time. He made an elaborate subdivision of *Nephrodium*, with free or anastomosing veins as a main distinction (vascular anatomy, scales, hairs and glands had no part in his system) and did not clearly separate thelypteroid ferns from the rest.

CARL CHRISTENSEN based his 'Index Filicum' (1905) mainly on DIELS but (following OTTO KUNTZE) he adopted the older name *Dryopteris* ADANSON (1763) in place of *Nephrodium*; under it he had the mixture as before. VAN ALDERWERELT VAN ROSENBURGH made a compilation of all recorded taxonomic information on Malesian ferns, with new descriptive data for many species, adopting CHRISTENSEN's scheme (except that he reverted to *Phegopteris* for exindusiate thelypteroids); this was published at Bogor in 1908. In subsequent years he published new descriptions of many species, his later observations being more detailed and critical, but in many cases he misapplied older names. C. A. BACKER & O. POSTHUMUS, in 'Varenflora voor Java' (1939) also adopted CHRISTENSEN's comprehensive *Dryopteris*, without attempting to separate thelypteroid species. Their work includes much new field observation but their citation of synonymy was often uncritical.

Having completed his Index, CHRISTENSEN realized that there was much mixture of unrelated species in his *Dryopteris* and he proceeded to make a detailed study of tropical American species. In the course of this work he distinguished thelypteroid ferns from the rest for the first time (Monograph of the genus *Dryopteris*, Dansk Selsk. Skr. VII, 10, 1913, 55–282; VIII, 6, 1920, 1–132), but he retained all in *Dryopteris*, placing the thelypteroids in subgenera, because he had not studied the Old World species and could not foresee how to fit them into his scheme. In subsequent years CHRISTENSEN made many studies of ferns of the Old World, adding to his knowledge, and in 1929–1932 R. C. CHING worked with him, specializing on the ferns of China and India. CHING wrote an important series of papers in the decade 1930–1940, including monographic treatment of *Thelypteridaceae* in mainland Asia, in the genera *Thelypteris*, *Cyclosorus*, *Abacopteris* and *Leptogramma*. In 1940 he recognized for the first time a family *Thelypteridaceae*. I accepted CHING's scheme, with reservations, in my book 'Ferns of Malaya' (1955).

COPELAND's work on Philippine ferns began in 1904, soon became extended to cover those of neighbouring regions, and culminated in his 'Genera Filicum' (1947) and 'Fern Flora of the Philippines' (1960). In the main, he accepted CHING's genera, but substituted *Lastrea* for *Thelypteris* which he regarded as illegitimate; he did not recognize a family *Thelypteridaceae*, and separated *Thelypteris* from *Cyclosorus* solely on the character of free or anastomosing venation; he regarded *Lastrea* as closely related to *Athyrium*.

In 1963 CHING elaborated his scheme of classification of *Thelypteridaceae* in mainland Asia, recognizing some new genera. K. IWATSUKI made a detailed study of morphology in the family, mainly in Japan and China, and published a new taxonomic survey in 1964–1965, recognizing the three genera *Stegnogramma*, *Thelypteris* (with many subdivisions) and *Meniscium*.

I began a study of all Old World species of the family in 1967, examining the types of almost all species and the complete collections in several major herbaria. I discovered that Malesian species are far more varied than those of mainland Asia, and I thus had a wider field of study than CHING and IWATSUKI. I devised a new scheme of genera which was published in 1971, and subsequently monographs of all Old World species of the major genera except *Sphaerostephanos* which is almost entirely Malesian and is here treated fully for the first time.

My first conclusion (at which I had already hinted in my book of 1955 on the ferns of Malaya) was that a division between *Thelypteris* and *Cyclosorus* based on free or united veins was not a natural one. I also concluded that the nature and distribution of glands and hairs provided important evidence which had never been well recorded. In such a perspective *Thelypteris* and *Cyclosorus*, restricted to their type species and near allies, are small and distinctive groups not closely allied to most of the species associated with them by previous authors. There thus appeared to be two alternatives: to include all species of the family in one genus *Thelypteris*, or to recognize a number of separate genera. I chose the latter because there is such a great diversity in Malesia that within a single genus, to be intelligible,

one would always have to specify a subgeneric or sectional name when citing a species; a specific name alone would not give sufficient information.

In the New World are some other distinctive groups, one of which (*Amauropelta*) extends across Africa to the Mascarene Islands (Holtum, J. S. Afr. Bot. 40, 1974, 130), doubtfully to Ceylon and not to Malesia. The New World genus *Meniscium* is mentioned under the genus *Pronephrium* in the present work. The species of islands in the Pacific Ocean eastwards from New Guinea (about 100) are almost all common to Malesia or related to Malesian species (Allertonia 1, pt 3, 1977).

The result of this long history of confusion is that all names published in the 19th century have been transferred, by one author or another, to *Aspidium*, *Nephrodium* and *Dryopteris*, in some cases also to *Goniopteris*, *Lastrea*, *Meniscium* or *Phegopteris*; and in the 20th century most names have been transferred to *Thelypteris* or *Cyclosorus* or both. In view of the preference by some people for a comprehensive genus *Thelypteris*, I have cited names in that genus if such have been published, and I have tried to avoid the use of new specific epithets where such would have to be changed on transfer to *Thelypteris*.

Few species were originally described in terms which distinguish them clearly from others, with the result that names were often mis-used or new ones needlessly created. Few collectors understood how to distinguish between species of this family and the need for careful preservation of the base of a frond; much herbarium material is therefore in some measure unsatisfactory and new collections by specialists are still needed. Too many species (my own included) are based on a single collection which may not adequately show possible variation; but in many other cases repeated collections show a degree of uniformity which confirms their status. It cannot be doubted that the number of species in Malesia is very large, and that probably more remain to be discovered.

*Relationship to other groups.* In Journ. Linn. Soc. Bot. 53 (1947) 130–133 I commented on resemblances between *Thelypteridaceae* and *Cyathea*, and listed them more fully in Blumea 19 (1971) 18–19: shape of fronds; shape of leaflets; abundant hairs on adaxial surfaces of rachis quite distinct in nature from scales; arrangement of aerating tissue with a separate small area at the base of each pinna (this area sometimes swollen both in *Cyathea* and in *Thelypteridaceae*); relationship of sori to veins. As *Cyathea* has invariably deeply lobed leaflets and free veins, there is not scope for development of a sinus-membrane, but there is a rudiment of it, especially in *Cyathea* subg. *Sphaeropteris* sect. *Schizocaena* of my arrangement in Flora Malesiana. *Cyathea* has a base chromosome number 69, about double that of members of *Thelypteridaceae*; *Cyathea* has also a much more complex vascular system. In some species of *Cyathea* the lower pinnae are gradually reduced, in others there is a long stipe and the lowest pinnae are not much reduced; in *Thelypteridaceae* also both these conditions occur.

Most species of *Cyathea* have amply bipinnate fronds, but young plants of all of them have simply pinnate fronds. I suggest that the evolution of *Thelypteridaceae* began by the persistence of the simply pinnate form in an adult condition (neoteny). I further suggest that those extant *Thelypteridaceae* which have bipinnate fronds are a secondary development from simply pinnate ancestors. Their pinnules are always adnate to the pinna-rachis in a way not found in *Cyathea*.

*Cyathea* fronds have free veins, and it is likely that this was a character also of early *Thelypteridaceae*. But it is probable that the distinctive pattern of anastomosis of veins, with its precise relationship to sinus-membranes (a pattern found in no other ferns) originated early. In some of the genera here recognized it seems probable that the species with free veins are not primitive in their own genera; for example, in *Sphaerostephanos* (the largest genus in Malesia) the great majority of species have anastomosing veins, the few species which have free veins not forming a closely allied group nor limited to one area. The same is true in *Pneumatopteris* and *Christella*. But there are other genera which perhaps evolved directly from free-veined ancestors (e.g. *Coryphopteris* and *Trigonospora*).

There is another group of terrestrial ferns which agree with *Thelypteridaceae* in having abundant distinctive hairs, not homologous with scales, on the adaxial surface of frond-axes, namely *Ctenitis*, *Tectaria* and allied genera. The latter differ from *Thelypteridaceae* in

vascular anatomy of stipes, shape of fronds (pinnae often asymmetric at their bases, basal pinnae enlarged basiscopically), have a different kind of anastomosis of veins, lack sinus-membranes, and the hairs on the adaxial surface of frond-axes are always multicellular with short cells, not acicular in form. I see no close alliance between *Thelypteridaceae* and other groups, but point out the similarity of sori to those of *Tectaria*, *Dryopteris* and other genera, which seems to me to imply a common ancestry from ancient tree-ferns (see Journ. Linn. Soc. Bot. 67, Suppl., 1973, 5).

In his recent scheme of classification of ferns (Webbia 31, 1977, 313–512), PICHI SERMOLLI places *Thelypteridaceae* in *Aspidiales*, an Order which he regards as related more nearly to *Dennstaedtiales* than to *Dicksoniales*. Within *Aspidiales* he regards *Thelypteridaceae* as nearest to *Aspleniaceae*, but in my view these two families have little in common except the chromosome number 36 in a majority of species and should not be placed in the same Order. PICHI SERMOLLI regards a creeping rhizome as probably primitive in *Thelypteridaceae* (p. 441) and (ignoring the genus *Trigonospora*) states that difference in spores is an argument against a relationship to *Cyathea* (p. 437); he does not mention the various similarities to *Cyathea* indicated above. After reading his statement, I cannot agree with his arrangement, either in reference to *Thelypteridaceae* as a whole or as to the interrelations of genera within it. As regards the latter, he offers no justification for the subdivision proposed on pp. 440–445; for example, he places *Thelypteris* and *Cyclosorus* wide apart, without explanation, whereas they seem to me to be rather nearly related.

I assume an erect caudex to be primitive in *Thelypteridaceae* partly because I regard a common origin with *Cyathea* as probable, and partly because the caudex in all species has the radial structure characteristic of an erect habit; in none of the species with a creeping rhizome has a dorsiventral structure (of the kind occurring in *Dennstaedtia*) developed. All species of *Thelypteridaceae* which have long creeping rhizomes appear to me to be more specialized than those with an erect caudex; nearly all of the former are plants of open places, whereas the great majority of members of the family are adapted to a forest habitat. *Cyclosorus* and *Thelypteris* (in the strict sense here adopted) are ferns of freshwater swamps in sunny places. *Sphaerostephanos unitus* and *S. invisus* also grow in the open, usually in less wet places, and are among the very few species in that large and varied genus which have a long-creeping rhizome.

I agree that, in evolution, the megaphyll of ferns may have been derived from a branch-system arising from a creeping rhizome, but if so that stage occurred very early, before any groups now known originated. In 1949 the idea was in my mind that living *Gleicheniaceae*, with their long-creeping rhizomes, might preserve an original plant-form, and that, as suggested by BOWER, *Cyathea* might have originated from a *Gleichenia*-like ancestor (Biol. Reviews 24: 268). But after making a survey of the tree-ferns in the present Series (vol. 1, part 2) I concluded that the erect habit was probably primitive for *Cyathea*, and that the plant-form (though not the form of sporangia) of modern *Gleicheniaceae* is probably derivative and not primitive (there is no evidence of its existence before the Cretaceous); I have discussed this theme in Phytomorphology 14 (1965) 477–480.

CONSPECTUS OF MALESIAN GENERA

- 1. Upper surface of costae not grooved; veins not reaching margin (except distal ones in *Phegopteris*)  
Group of PHEGOPTERIS
- 2. Fronds bipinnate; n = 31.
  - 3. Scales thin; perispore forming a reticulum of few meshes separated by low broad ridges  
1. **Pseudophegopteris**
  - 3. Scales thickened at base; perispore minutely complex . . . . . 2. **Macrothelypteris**
- 2. Fronds simply pinnate; n = 30 or 35.
  - 4. Basal scales with short superficial setae; pinnae free; n = 35 . . . . . 3. **Metathelypteris**
  - 4. Basal scales flat with marginal hairs; pinnae with semicircular rachis-wings between them; n = 30  
4. **Phegopteris**
- 1. Upper surface of costae grooved; veins all reaching margin.
  - 5. n = 33 or less; sporangia sessile, lacking glands or hairs . . . . . Group of CORYPHOPTERIS



6. Caudex erect; spores with thin translucent wing; plants of mountain ridges in Malasia . . . . . **5. *Coryphopteris***
6. Caudex slender, creeping; spores various; a mixture still unresolved . . . . . **6. *Parathelypteris***
5.  $n = 36$  or  $35$ ; sporangia stalked, in many cases bearing glands or setae.
7. No reduced pinnae at base of frond; subentire pinnae with goniopteroid or meniscioid venation rarely present.
8. No glands or hairs on body of sporangia except in *Thelypteris*.
9. Caudex short, erect; spores trilete with discontinuous perispore forming minute papillae; no scales on costae . . . . . Group of **TRIGONOSPORA**
10. On rocks by streams, S.E. Asia and W. Malasia . . . . . **7. *Trigonospora***
10. (Related genus in Africa: *Menisorus*)
9. Caudex creeping; spores monolete with ample perispore; scales present on lower surface of costae . . . . . Group of **THELYPTERIS**
11. No large red glands on hairs on sporangium-stalks nor on lower surface of costae . . . . . **8. *Thelypteris***
11. Large red glands on hairs of sporangium-stalks, sometimes on lower surface of pinnae also.
12. Veins free; forest plants of Malasia . . . . . **9. *Mesophlebia***
12. Veins anastomosing; plants of wet ground in the open.
13. Fronds not proliferous; no forked hairs present . . . . . **10. *Cyclosorus***
13. Fronds proliferous; forked hairs present . . . . . **11. *Ampelopteris***
8. Glands or setae usually present on body of sporangia . . . . . Group of **CHINGIA**
14. Veins anastomosing, with long sinus-membrane . . . . . **12. *Chingia***
14. Veins free; sinus-membrane short; decurrent obliquely towards costa . . . . . **13. *Plesioneuron***
7. Reduced pinnae usually present at base of frond; species without such pinnae mostly having broad subentire normal pinnae.
15. Hooked hairs on frond; veins free . . . . . **14. Isolated genus *Cyclogramma***
15. Hooked hairs present only in *Pronephrium* sect. *Grypotherix* which has much anastomosis of veins.
16. Spores with many small wings or a  $\pm$  continuous translucent wing with cross-wings; aerophores  $\pm$  swollen . . . . . Group of **SPHAEROSTEPHANOS**
17. Broad thin scales, lacking superficial hairs, on base of stipe; capitate hairs, rarely setae, or neither, on sporangia.
18. Veins free; lamina between them not pustular when dry . . . . . **15. *Pseudocyclosorus***
18. Veins in most species anastomosing; lamina between them pustular when dry . . . . . **16. *Pneumatopteris***
17. Scales on base of stipe narrow, hairy on surface; spherical glands on setae usually present on sporangia.
19. Reduced pinnae normally present . . . . . **17. *Sphaerostephanos***
19. Reduced pinnae lacking.
20. Sori in most species round or nearly so; pinnae mostly free.
21. Pinnae rarely to 20 pairs; veins anastomosing . . . . . **18. *Pronephrium***
21. Pinnae to 30 pairs, not over 2.5 cm long . . . . . **19. *Nannothelypteris***
20. Sori always elongate along veins; pinnae mostly adnate; sporangia always setiferous . . . . . **20. *Stegnogramma***
16. Spores coarsely tuberculate or ridged; aerophores not or rarely swollen; elongate glands often present . . . . . Group of **CHRISTELLA**
22. Basal large pinnae much narrowed at base; 1-2 pairs of reduced basal pinnae inconstantly present; venation in several species inconstant . . . . . **21. *Amphineuron***
22. Basal pinnae not much narrowed at base, usually auricled; a few pairs of lower pinnae gradually reduced, lowest not very small . . . . . **22. *Christella***

The above conspectus does not attempt to state all characters of the various divisions, but is an attempt to show inter-relations as I see them at present.

*Pseudophegopteris* and *Macrothelypteris* have bipinnate fronds approaching those of *Cyathea* in size but differ in their mainly adnate pinnules; as above noted, I doubt whether they are to be regarded as primitive in the family. Other genera have more definitely primitive characters, e.g. the miniature arborescent habit of *Coryphopteris*, the trilete spores of *Trigonospora*, but the latter has 36 chromosomes and may be related to *Pseudocyclosorus*. *Coryphopteris* plants are confined to acid peaty soil on mountain ridges, where they grow with *Plagiogyria* which is certainly a primitive relic. In the New World (and to a small



extent in Africa) *Amauropelta*, in habit mainly similar to *Coryphopteris*, is a comparable genus (of 200 species) but differs in having lower pinnae almost always gradually reduced whereas that condition is rare in *Coryphopteris*.

The genera *Thelypteris*, *Mesophlebion*, *Cyclosorus* and *Ampelopteris* seem to be a natural group with peculiar glands, scaly costae, creeping rhizome and unreduced basal pinnae. *Mesophlebion* looks like the primitive element, adapted to a forest habitat; the other genera have become adapted to open swampy ground and, like many other swamp-plants, are widely distributed (it should be noted that *Mesophlebion chlamydophorum* grows in swamp-forest). In my judgement, most species which have been included in *Cyclosorus* are not at all nearly related to this group of genera. *Ampelopteris* is peculiar in having forked hairs on the rachis similar to those of the American genus *Goniopteris* (in the strict sense of CHRISTENSEN's monograph) but is not otherwise much like *Goniopteris*; if they have a common ancestor it must be rather far back.

*Cyclogramma* is a peculiarly isolated genus of a few species in mainland Asia (one of them reaching northern Luzon). I doubt whether its hooked hairs indicate a relationship to *Pronephrium* sect. *Grypothrix*; it should be noted that slender hooked hairs occur also in some species of *Amauropelta* which is not nearly related to either *Cyclogramma* or *Pronephrium*.

The series of genera from *Pseudocyclosorus* to *Stegnogramma* comprise the great majority of Malesian species of the family, and I judge that this is a natural group; the genera within it are not easy to characterize clearly, though typical species in each are distinct enough. Most species of the group have anastomosing veins, but in most genera there are some species with free veins, which again indicates the unnatural state of COPELAND's distinction between *Lastrea* and *Cyclosorus* by the character of free or anastomosing veins. Most of these ferns have reduced basal pinnae, but there is much variation, and I can find no sharp division between *Pronephrium* and *Sphaerostephanos*; I maintain these two genera partly for convenience and partly because many members of *Pronephrium* do form a group distinct from typical *Sphaerostephanos*. The whole question needs much further study; it will not be solved by examining a few species.

The final group of two genera, *Christella* and *Amphineuron* is perhaps also related to the *Sphaerostephanos* group, but appears to be distinct in its spores and glands.

Unicellular glands of one sort or another are characteristic of most genera. In many cases these glands are distinctive when seen at a magnification of not less than  $\times 25$ , but they are in some measure modified in the process of preparing specimens for the herbarium, and their differences are not easy to describe. They need a microchemical study.

The great range of variation in detail within almost all genera appears to me to indicate that the family is still in an active state of evolution. I cannot agree with LÖVE, LÖVE and PICH SERMOLLI that "most of the recognized species of pteridophytes are evidently old and well-established taxa" (p. xiv) nor that "the species of ferns are usually clearly distinct and established through their substantial age" (p. xi), having an existence of "millions of generations" (p. xiii). It seems to me evident that genera and species in *Thelypteridaceae* are in most cases not older than those in many families of Angiosperms.

*Citation of literature and synonyms.* An attempt has been made to include all binomials based on Malesian species, with citation of types, all of which have been examined except where otherwise indicated. Binomials based on extra-Malesian species which are regarded as synonyms are in most cases cited, or reference is made to their treatment in other recent literature. Descriptions published in works on Malesian ferns are in all cases cited, though some of them are of doubtful value. BEDDOME's work is also cited, as he included information on ferns of Malaya, and information about the occurrence of Malesian species in India; similarly the *Flore Générale de l'Indochine* is often also cited. Some of this information occurs also in my precursory papers, but in some of these the information is incomplete, and in all cases the work has been revised for the present Flora.

*Descriptive details.* So far as possible, these are arranged in the same sequence for all species. The distance between costules is measured along the costa from which they arise; this can be more exactly stated than the width of pinna-lobes. The nature and distribution of

glands and hairs is separately indicated for the lower (abaxial) and upper (adaxial) surfaces; those on the lower surface are usually more distinctive, but often both need to be observed to provide clear distinctions between allied species. Failure to observe differences in these characters has caused much confusion among earlier authors, and more information still remains to be recorded. Spores have only been approximately described. I hope that a separate publication on spores in the family may later be possible.

The key to genera which follows is artificial (the numbers of the genera are those of the Conspectus) and is designed to lead as simply as possible to the right genus for any species in Malasia. It will not serve a similar purpose for all species in the Old World. I have compiled taxonomic studies of all species in Africa and adjacent islands (J. S. Afr. Bot. 40, 1974, 123–168) and in Australasia and the Pacific (Allertonia 1, part 3, 1977). Most Indian species are covered in my precursory papers in *Blumea* or elsewhere, as cited under the genera.

#### KEY TO THE GENERA IN MALESIA

1. Costae not grooved on upper surface; veins not reaching margin.
  2. Fronds bipinnate.
    3. Scales on lower surface of frond, if present, consisting of a row of cells with red cross-walls acicular hairs all unicellular . . . . . **1. Pseudophegopteris**
    3. Scales on axes of frond thickened at base, or replaced by long slender septate acicular hairs . . . . . **2. Macrothelypteris**
  2. Fronds simply pinnate.
    4. Stipe-scales bearing superficial hairs; rachis-wing, if present, narrow and of even width.
      5. Sori indusiate . . . . . **3. Metathelypteris**
      5. Sori exindusiate . . . . . **1. Pseudophegopteris**
    4. Stipe-scales with marginal hairs only; pinnae connected by wings along the rachis forming semicircular lobes between pinnae . . . . . **4. Phegopteris**
1. Costae grooved on upper surface; free veins all reaching margin.
  6. Fronds simple, or pinnate with lower pinnae not decrescent (small basal pinnae inconstantly present in *Amphineuron*).
    7. Spores trilete; caudex short, erect; on rocks by streams . . . . . **7. Trigonospora**
    7. Spores normally monolet; caudex and habitat various.
      8. Rhizome long-creeping in wet ground; broad flat scales present on lower surface of costae.
        9. Veins free . . . . . **8. Thelypteris**
        9. Veins anastomosing.
          10. Fronds not proliferous; sori indusiate . . . . . **10. Cyclosorus**
          10. Fronds proliferous; sori exindusiate . . . . . **11. Ampelopteris**
    8. Not this combination of characters.
      11. Caudex erect; sporangia unstalked, lacking hairs and glands; some sessile resinous glands on lower surface in most species; plants of mountain ridges . . . . . **5. Coryphopteris**
      11. Not this combination of characters.
        12. Caudex massive, erect; scales narrow, rigid, brittle; sori close to costules, exindusiate or with very small indusia . . . . . **12. Chingia**
        12. Not this combination of characters.
          13. Sori elongate along veins, exindusiate; sporangia bearing slender straight setae . . . . . **20. Stegnogramma**
          13. Sori round, or if elongate and exindusiate the sporangia bearing hooked hairs or none.
            14. Veins free.
              15. Basal basicopic vein of each group arising from costa below the attachment of its costule; a red gland at the end of hairs on stalks of sporangia . . . . . **9. Mesophlebion**
              15. Basal basicopic vein of each group not always thus arising; hairs on sporangium-stalk otherwise.
                16. Rhizome long-creeping; no glands nor hairs on sporangia.
                  17. Rhizome slender; pinnae rarely over 6 cm long . . . . . **6. Parathelypteris**
                  17. Rhizome 5–7 mm diameter; pinnae 10 cm or more long . . . . . **22. Christella**
                16. Rhizome not long-creeping; sporangia in some cases with glands or hairs.
                  18. Bases of lower pinnae not greatly narrowed.
                    19. Pinnae rigid, commonly at least 10 × 1 cm . . . . . **13. Plesioneuron**
                    19. Pinnae thin, to 3 cm long, rarely 1 cm wide.

20. Sporangia bearing glands.  
 21. Pinnae 20–30 pairs, no glands on their lower surface . . . . . 19. *Nannothelypteris*  
 21. Pinnae c. 7 pairs; glands present . . . . . 18. *Pronephrium*  
 20. Sporangia lacking glands . . . . . 22. *Christella*  
 18. Bases of lower pinnae much narrowed . . . . . 21. *Amphineuron*  
 14. Veins anastomosing.  
 22. Spores coarsely tuberculate or ridged; sporangia lacking glands.  
 23. Basal pinnae much narrowed at their bases . . . . . 21. *Amphineuron*  
 23. Basal pinnae not much narrowed at their bases which are in most cases auricled on acroscopic side . . . . . 22. *Christella*  
 22. Spores with a thin wing and cross-wings or many small thin wings.  
 24. Pinnae 20 pairs or more, 2–3 cm long . . . . . 19. *Nannothelypteris*  
 24. Pinnae much longer, or fewer.  
 25. Pinnae or simple fronds subentire; lower surface between veins often pustular . . . . . 18. *Pronephrium*  
 25. Pinnae deeply lobed; surface between veins not pustular . . . . . 17. *Sphaerostephanos*  
 6. Lower pinnae gradually reduced, or an abrupt change to small pinnae at base of frond.  
 26. Hooked hairs present on lower surface of frond . . . . . 14. *Cyclogramma*  
 26. Hooked hairs lacking.  
 27. Rhizome slender, long-creeping; many lower pinnae gradually reduced; some septate acicular hairs on lower surface . . . . . 6. *Parathelypteris*  
 27. Not this combination of characters.  
 28. Caudex erect; pinnae to c. 5 cm long, lower ones gradually reduced; sporangia sessile, lacking glands or hairs; plants of high mountain ridges . . . . . 5. *Coryphopteris*  
 28. Not this combination of characters.  
 29. Basal scales on stipe in almost all cases broad and thin; lamina between veins on upper surface almost always smooth and glabrous, lower surface of costae never densely hairy; glandular hairs on lower surface, if present, minute and colourless.  
 30. Veins free; reduced basal pinnae consisting of an aerophore with a minute lamina; pinnae not pustular between veins on lower surface when dried . . . . . 15. *Pseudocyclosorus*  
 30. Veins anastomosing, or if free the reduced basal pinnae with a distinct green lamina; lower surface of pinnae between veins  $\pm$  pustular when dried . . . . . 16. *Pneumatopteris*  
 29. Basal scales narrow; upper surface between veins often bearing hairs and/or glands, lower surface of costae usually with copious hairs; sessile spherical or elongate glands often present.  
 31. Body of sporangium lacking hairs or glands; an elongate unicellular glandular hair on sporangium-stalk, similar hairs sometimes also on lower surface of veins; spores coarsely tuberculate or ridged . . . . . 22. *Christella*  
 31. Body of sporangium usually with sessile spherical glands or setae; hairs on sporangium-stalk consisting of several cells; spores with many small thin wings or a continuous wing with cross-wings; sessile spherical glands present on lower surface in many species . . . . . 17. *Sphaerostephanos*

### 1. PSEUDOPHEGOPTERIS

CHING, Acta Phytotax. Sinica 8 (1963) 313; HOLTUM, Blumea 17 (1969) 12. — *Thelypteris* group 4 CHING, Bull. Fan Mem. Inst. Biol. Bot. 6 (1936) 246. — *Phegopteris sensu* TAGAWA, Acta Phytotax. Geobot. 7 (1938) 73, p.p. — *Phegopteris sect. Lastrella* H. ITO in Nakai & Honda, Nov. Fl. Jap. n. 4 (1939) 152, excl. *P. decursive-pinnata*. — *Thelypteris subg. Phegopteris sect. Lastrella* K. IWATS. Mem. Coll. Sci. Univ. Kyoto B, 31 (1964) 25, (1965) 137, excl. *T. decursive-pinnata*. — *Toppingia* DEG., DEG. & A. R. SMITH in Deg. & Deg. Fl. Hawaii (1968) fam. 17b. — *Macrothelypteris sensu* PICHI SERMOLLI, Webbia 24 (1970) 715, p.p. — **Fig. 2a–g.**

Caudex erect or prostrate, in *P. aurita* long-creeping; scales thin with short hairs on surface; stipe and rachis glossy, in most cases castaneous. Lamina in most species bipinnate with pinnules adnate to pinna-rachis,

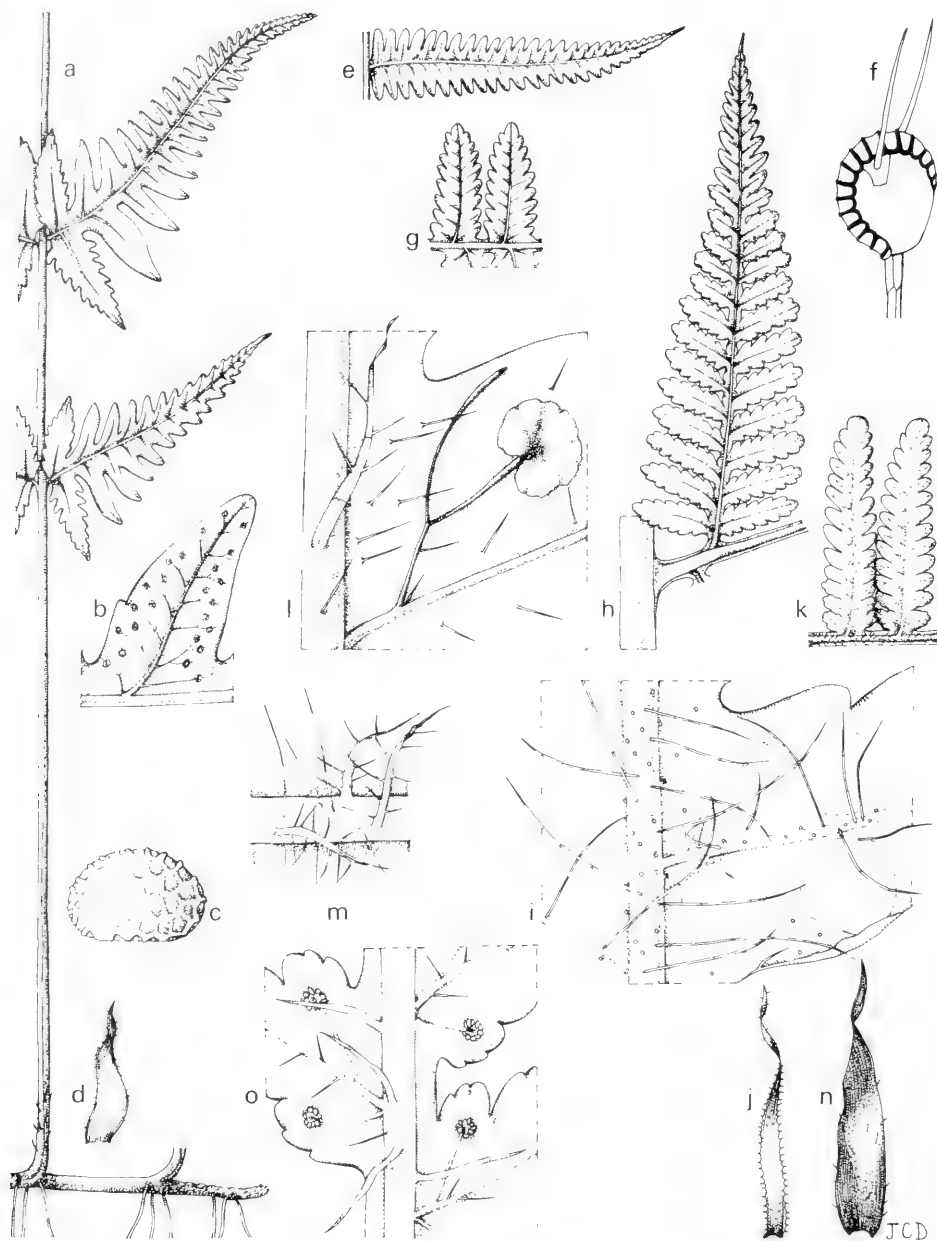


Fig. 2. *Pseudophegopteris aurita* (HOOK.) CHING. a. Rhizome and base of frond,  $\times 6$ ; b. lobe of a pinna,  $\times 3$ ; c. spore,  $\times 333$ ; d. scale from stipe,  $\times 6$ . — *P. rectangularis* (ZOLL.) HOLTUM. e. One pinna,  $\times 2/3$ ; f. sporangium,  $\times 33$ . — *P. paludosa* (BL.) CHING. g. Two pinna-lobes,  $\times 2/3$ . — *Macrothelypteris torresiana* (GAUD.) CHING. h. One pinnule,  $\times 2$ ; i. base of pinna-lobes (sori outlined),  $\times 24$ ; j. scale from stipe,  $\times 4$ . — *M. polypodioides* (HOOK.) HOLTUM. k. Pinnule-lobes,  $\times 2$ ; l. base of pinnule-lobes,  $\times 32$ ; m. scales on pinna-rachis,  $\times 2$ ; n. scale from stipe,  $\times 4$ . — *M. setigera* (BL.) CHING. o. Part of pinnule, showing hairs and scales,  $\times 12$  (a-d NAKAIKE 401, e-g MATTHEW s.n., h-n cult. Kew, o MOUSSET 718).

often connected by a narrow wing, in two species simply pinnate with lobed pinnae; pinnae opposite or nearly so, lower ones usually somewhat reduced and more widely spaced; tips of veins thickened, not running to margin; scales on lower surface of rachis and pinna-rachis few at maturity of frond, those on distal axes reduced to a single row of short cells with reddish cross-walls; hairs on lower surfaces unicellular, acicular or capitate or both. *Sori* always exindusiate, globose or  $\pm$  elliptic, in a few cases elongate along veins; sporangia bearing acicular hairs or not; spores usually pale, with a slightly-raised reticulum forming broad meshes on the surface.

Type species: *Pseudophegopteris pyrrhorhachis* (KUNZE) CHING.

Distr. St Helena, S. Tomé & Fernando Poo; tropical Africa; Mascarene Islands; tropical and subtropical Mainland Asia; *Malesia*; Samoa, Hawaii; about 20 spp.

Ecol. In *Malesia*, only on mountains at 1200–2800 m, often near streams, in open places; most species appear to be local, and have been little collected.

Cytol. Base chromosome number 31; *P. pyrrhorhachis* diploid, tetraploid and hexaploid (India, Ceylon); *P. aurita* diploid (N. India), tetraploid (New Guinea); *P. cyclocarpa* tetraploid; *P. rectangularis* tetraploid (N. India).

This genus has been united by PICHI SERMOLLI with *Macrothelypteris*, but the two are very distinct in scales and spores. *Pseudophegopteris* differs also in its invariable mountain habitat; this is seen strikingly in the Pacific where *Macrothelypteris torresiana* and *M. polypodioides* are widely dispersed at low altitudes. *Pseudophegopteris* represented only by two isolated mountain species in Samoa and Hawaii.

#### KEY TO THE SPECIES

1. Rhizome slender, wide-creeping; some sori elongate . . . . . 1. *P. aurita*
1. Rhizome erect, or if creeping thick with fronds near together; sori not elongate.
2. Pinnae to c. 6 cm long, nearly all adnate to rachis, lobed not more than  $\frac{3}{4}$  to costa . . . . . 2. *P. rectangularis*
2. Pinnae much longer, mostly not adnate to rachis and with adnate pinnules.
3. Basal basiscopic pinnules conspicuously longer than next.
4. Copious short capitate hairs present on lower surface of pinna-rachis and costae of pinnules . . . . . 3. *P. tenggerensis*
4. All hairs on lower surfaces acicular . . . . . 4. *P. cyclocarpa*
3. Basal basiscopic pinnules not conspicuously longer than next.
5. Pinnules on largest pinnae almost free, lobed almost to costa.
6. Lower surface of costae hairy; lobes of largest pinnules lobed almost to costule . . . . . 5. *P. kinabaluensis*
6. Lower surface of costae glabrous; lobes of largest pinnules almost entire . . . . . 6. *P. sumatrana*
5. Pinnules on largest pinnae all broadly adnate to pinna-rachis, lobed not more than half-way to costa . . . . . 7. *P. paludosa*

1. *Pseudophegopteris aurita* (HOOK.) CHING, Acta Phytotax. Sinica 8 (1963) 314; HOLTUM & ROY, Blumea 13 (1965) 131; HOLTUM, Blumea 17 (1969) 13. — *Gymnogramme aurita* HOOK. Ic. Pl. 10 (1854) t. 974, 989; Spec. Fil. 5 (1864) 141; BEDD. Ferns Brit. Ind. Suppl. (1876) 24. — *Phegopteris aurita* (HOOK.) J. SM. Cat. Cult. Ferns (1857) 13; Hist. Fil. (1875) 234; METT. Farnatt. IV (1858) 15. — *Polypodium auritum* (HOOK.) LOWE, Ferns Brit. & Exot. 2 (1858) t. 51. — *Leptogramma aurita* (HOOK.) BEDD. Handb. (1883) 377, f. 216. — *Dryopteris aurita* (HOOK.) C. CHR. Ind. Fil. (1905) 253. — *Thelypteris aurita* (HOOK.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 6 (1936) 266. — Type: GRIFFITH, Khasya Hills (K). — Fig. 2a–d.

Rhizome 2–3 mm diam. (dry), scales near apex

3–4 mm long. Stipe dark purplish, glossy, to 60 cm long. Lamina 30–70 cm long; pinnae well-spaced, commonly to 15 cm long, upper ones adnate to rachis merging with broadly deltoid apical lamina, lowest 1–2 pairs reduced; pinnae of largest fronds lobed almost to costa, lobes rounded to acute, basal lobes conspicuously longer than next, basal basiscopic lobes of largest pinnae 3–5 cm long, lobed up to half-way to costule; veins pinnate in the pinna-lobes, simple or forked; rachis short-hairy on upper surface, glabrous beneath; costae densely short-hairy on both surfaces, rest glabrous. *Sori* elongate to globose along middle to distal part of veins; sporangia setose.

Distr. N. E. India to S. W. China, Tonkin; in *Malesia*: Sabah (Mt Kinabalu, CLEMENS 40306, MOLESWORTH ALLEN 3234), Philippines (Luzon,

PRICE 836, Mt San Cristobal), Papua New Guinea (several coll.).

Ecol. In Malesia at 1400–2200 m, in open places.

**2. *Pseudophegopteris rectangularis* (ZOLL.) HOLTUM**, Blumea 17 (1969) 19. — *Polypodium rectangulare* ZOLL. Syst. Verz. (1854) 37, 48. — *Thelypteris rectangularis* (ZOLL.) NAYAR & KAUR, Comp. to Bedd. (1974) 72. — Type: ZOLLINGER 1802, Tjiapoos, Java (G; L, LE, P).

*Polypodium distans* DON var. *minor* CLARKE, Tr. Linn. Soc. II Bot. I (1880) 545, t. 79, f. 1. — Type: CLARKE, Sikkim (K).

*Dryopteris mousetii* ROSENST. Fedde Repert. 8 (1910) 278. — *Phegopteris mousetii* (ROSENST.) v.A.v.R. Handb. Suppl. (1917) 306. — Type: MOUSSET s.n. Tengger Mts, Java (isotype FI).

*Phegopteris oppositipinna* v.A.v.R. Bull. Jard. Bot. Btzg II, 16 (1914) 24; Handb. Suppl. (1917) 307. — *Thelypteris oppositipinna* (v.A.v.R.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 6 (1936) 268; HOLTUM, Rev. Fl. Malaya 2 (1955) 239, f. 137. — *Pseudophegopteris oppositipinna* (v.A.v.R.) CHING, Acta Phytotax. Sinica 8 (1963) 315. — Type: MATTHEW, G. Singgalan, Sumatra (BO; K). — Fig. 2e–f.

*Caudex* short, suberect. *Stipe* to 25 cm long, dark purplish, bearing short sparse spreading hairs, scaly near base. *Lamina* to 30 × 12 cm, narrowed to both ends, several pairs lower pinnae more widely spaced; free pinnae few, rest with base of lamina ± adnate to rachis; *largest pinnae* 6 × 1.5 cm, narrowed evenly from base to apex, lobed up to  $\frac{3}{4}$  to costa at base, lobes entire, rounded; veins in basal pinna-lobes 5 or more pairs; rachis, costae and costules beneath with hairs 0.5 mm long, some capitate hairs between veins. *Sori* ± globose, subterminal on veins, sporangia with slender setae.

Distr. N. E. India, W. Malesia: Sumatra, Malaya, Borneo, Java.

Ecol. On mountains at 1000–1500 m, in open sandy places by streams.

**3. *Pseudophegopteris tenggerensis* HOLTUM**, Reinwardtia 8 (1974) 500. — Type: BUYSMAN 40, Tengger Mts, Nongko, 1200 m, 1906 (U).

*Caudex* unknown. *Stipe* castaneous, glossy. *Largest pinnae* 33 cm long, subpinnate; pinnules lobed, all broadly adnate and connected by a narrow wing on pinna-rachis, basal basisopic pinnule 7 × 1.6 cm, conspicuously longer than next; lower surface of pinna-rachis and of costae of pinnae bearing copious short capitate hairs and a few acicular hairs, upper surface bearing spreading brown acicular hairs only. *Sori* almost globose, those on lower veins ellipsoid; sporangia lacking setae.

Distr. Malesia: East Java. Known only from type and two other specimens at Utrecht, possibly all from same source.

**4. *Pseudophegopteris cyclocarpa* HOLTUM**, Blumea 13 (1965) 131; Blumea 17 (1969) 15. — Type: cult. Hort. Bot. Kew. 578/63 n. 57, origin near Mt Hagen, Western Highlands, Papua New Guinea, 2000 m, leg. HOLTUM (K).

*Caudex* branching; branches short, suberect. *Stipe* to 60 cm long, dark purplish brown, scaly and hairy near base, scales 6 × 1 mm. *Lamina* to 80 cm or more long, basal pinnae reduced; *largest pinnae* to 20 cm long, narrowly deltoid; pinnules all broadly adnate to pinna-rachis, lowest pair almost free, basisopic one to 4.5 × 1.4 cm, acroscopic to 3.5 × 1.2 cm, lobed  $\frac{2}{3}$  towards costa; next pair of pinnules c. 4 and 2.5 cm long, rest of pinna evenly narrowed towards apex, middle pinnules 7–8 mm wide; veins pinnate in lobes of pinnules; acicular hairs present on lower surface of pinna-rachis at least near its apex, also on costae of pinnules and near margin. *Sori* medial on veins, globose or nearly so; sporangia copiously setose.

Distr. Malesia: Papua New Guinea. Known from type and two other collections from Western Highlands at 2000–2800 m, also one from Morobe District at 2000 m.

**5. *Pseudophegopteris kinabaluensis* HOLTUM**, Blumea 17 (1969) 16. — Type: H. P. FUCHS 21475, Mt Kinabalu, 2700 m (SRR; K, L).

*Caudex* not seen. *Stipe* to 150 cm long, pale brownish, with rachis bearing scattered narrow scales on lower surface. *Lamina* c. 150 cm long, lowest pinnae not or little reduced; *largest pinnae* 40 cm long, lower pinnules 2.5–3 cm apart, adnate slightly to rachis on acroscopic side; largest pinnules 10 × 3 cm, at base lobed almost to costa; costules to 6 mm apart, lobes incised up to halfway to costule; lower surface of costae of pinnules bearing slender spreading hairs and small uniseriate scales, hairs on upper surface more abundant and thicker. *Sori* almost globose; sporangia not setiferous.

Distr. Malesia: Sabah (Mt Kinabalu). Only known from type and one other collection, from wet inundated ground in narrow Goking's valley at 2700–2800 m.

**6. *Pseudophegopteris sumatrana* HOLTUM**, Blumea 17 (1969) 22. — Type: HOLTUM 26211, Kerinci Peak, 2000 m, Sumatra (K; BO, SING).

*Caudex* of type not recorded; of New Guinea specimens erect. *Stipe* 100 cm long, reddish. *Lamina* 150 cm long; lower pinnae distinctly reduced, largest c. 30 cm long; pinnules on basisopic side longer than on acroscopic; *largest pinnules* 7.5 × 1.7 cm, acuminate, partly adnate at base to pinna-rachis, lobed  $\frac{3}{4}$  towards costae, lobes subentire with rounded apices, costules 3–6 mm apart, veins mostly forked; lower surface of rachis, costae and costules glabrous. *Sori* above the fork on a vein, sometimes on both branches, almost globose; sporangia not setiferous.

Distr. *Malesia*: Central West Sumatra (Mt Kerinci). In addition to the type, several collections from Papua New Guinea at 1700–2300 m appear to be referable to this species.

Ecol. Open place by small stream.

Note. *P. sumatrana* is related to *P. kinabaluensis* but smaller, and glabrous on lower surface. New Guinea specimens resemble the Sumatran type, not the plants from Kinabalu, but it is possible that the two should be united.

7. *Pseudophegopteris paludosa* (BL.) CHING, Acta Phytotax. Sinica 8 (1963) 315; HOLTUM & ROY, Blumea 13 (1965) 131; HOLTUM, Blumea 17 (1969) 23. — *Aspidium paludosum* BL. Enum. Pl. Jav. (1828) 168, non RADDI 1825. — *Polypodium paludosum* BL. Fl. Jav. Fil. (1851) 192, t. 90; HOOK. Spec. Fil. 4 (1862) 214. — *Macrothelypteris paludosa* (BL.) LÖVE & LÖVE, Taxon 26 (1977) 325. — Type: BLUME, Java (L, n. 908,335–309).

*Polypodium distans sensu* RACIB. Fl. Buitenz. 1 (1898) 96. — *Dryopteris distans sensu* V.A.V.R. Handb. (1908) 496, p.p. — *Dryopteris brunnea* (WALL.) C. CHR. Ind. Fil. (1905) 255, nom. nud.; BACKER & POSTH. Varenfl. Java (1939) 46, p.p. — *Thelypteris brunnea sensu* CHING, Bull. Fan Mem. Inst. Biol. Bot. 6 (1936) 74, p.p.; HOLTUM, Rev. Fl. Malaya 2 (1955) 240 p.p. — *Lastrea pyrrhorhachis sensu* COPEL. Fern Fl. Philip. (1960) 330 p.p. — Fig. 2g.

*Caudex* massive, erect; stipe and rachis dark reddish. *Frond* with stipe to more than 200 cm long; 2–4 pairs lower pinnae gradually reduced; largest pinnae 20–35 cm long, bearing broadly adnate segments or pinnules 2.5–4 cm long which are contiguous except in largest pinnae; costules 10–12(–15) mm apart; basal basiscopic pinnules largest but not much longer than next; lower surface of pinna-rachis, costae, costules and veins bearing slender acicular hairs almost 1 mm long. *Sori* globose or nearly so; sporangia usually not setose.

Distr. Apparently throughout *Malesia*, to Eastern New Guinea, on mountains at 1200–2500 m, but specimens are few.

Ecol. BLUME's type was from an open swamp. The first collection from Malaya was in a small forest clearing at Cameron Highlands; now where much of the forest is cleared plants are abundant along streams at 1500 m. At Fraser's Hill quite small plants, on drier ground, have fertile fronds.

Notes. The specific epithet *brunnea*, taken up by CHRISTENSEN in Index Filicum and subsequently used by several authors, was never validated. This Malesian species differs from the Indian *P. pyrrhorhachis* (KUNZE) CHING in its massive erect caudex and larger size. I cannot decide, from herbarium specimens, how many species of this alliance occur in India; there, as in *Malesia*, more field work is needed.

## 2. MACROTHELYPTERIS

(H. ITO) CHING, Acta Phytotax. Sinica 8 (1963) 308; HOLTUM, Blumea 17 (1969) 25; Allertonia 1 (1977) 177. — *Thelypteris* group 10 CHING, Bull. Fan Mem. Inst. Biol. Bot. 6 (1936) 248. — *Thelypteris* sect. *Macrothelypteris* H. ITO in Nakai & Honda, Nov. Fl. Jap. n. 4 (1939) 141; K. IWATS. Acta Phytotax. Geobot. 18 (1960) 155. — *Thelypteris* subg. *Thelypteris* sect. *Metathelypteris* K. IWATS. Mem. Coll. Sci. Univ. Kyoto B, 31 (1965) 145, p.p. — Fig. 2h–o.

*Caudex* short, creeping or suberect; scales (also on base of stipe) narrow, ± thickened at least near base, with marginal and superficial acicular and/or capitate hairs. *Lamina* bipinnate-tripinnatifid with ± adnate pinnules; lowest pinnae little reduced; scales on rachis and pinna-rachis narrow, pallid, thickened at base and sometimes wholly terete, with or without marginal hairs; hairs on surface of frond slender and acicular or short and capitate, some long multicellular hairs always present. *Sori* always small, usually with a small but persistent indusium often hidden by mature sporangia; sporangia bearing capitate hairs; spores with a very fine surface reticulum not resolvable by light microscope, and slight wings.

Type species: *Macrothelypteris oligophlebia* (BAK.) CHING.

Distr. Mascarene Islands; warmer parts of mainland Asia; *Malesia*; Queensland; islands of the Pacific (including Hawaii) south to Kermadec Island; 10 species.

As pointed out by CHING, the type selected by ITO is a little-known species from central China. In 1969 I placed it as a variety of *M. torresiana*, but I am now doubtful about this, and have not seen enough material to make a good judgement. In 1965 IWATSUKI included this genus in *Thelypteris subg. Thelypteris* sect. *Metathelypteris* but the scales of the latter (here ranked as a genus) are different, also the chromosome number.

Cytol. Base chromosome number 31; *M. ornata* diploid (N. India); *M. torresiana* tetraploid (India, Ceylon, Singapore) and hexaploid (Ceylon); *M. viridifrons* tetraploid (Japan).

## KEY TO THE SPECIES

1. Rachises and lower surface of axes of frond lacking scales . . . . . **1. *M. torresiana***
1. Rachis, pinna-rachises and axes of pinnules scaly on lower surface.
  2. Scales on main rachis sparse; scales on pinna-rachis copiously ciliate . . . . . **2. *M. polypodioides***
  2. Scales on main rachis abundant, with strongly thickened bases; scales on pinna-rachis not or little ciliate.
    3. Basal scales thin; scales on rest of stipe and rachis flat above the terete base . . . **3. *M. setigera***
    3. Basal scales rigid with inflexed edges; scales on rest of stipe and rachis almost wholly terete . . . **4. *M. multiseta***

**1. *Macrothelypteris torresiana*** (GAUD.) CHING, Acta Phytotax. Sinica 8 (1963) 310; HOLTUM, Blumea 17 (1969) 27, excl. syn. *Polypodium fragile* BAK. — *Polystichum torresianum* GAUD. in Frey. Voy. Uran. Physic. Bot. (1828) 333. — *Thelypteris torresiana* (GAUD.) ALSTON, Lilloa 30 (1960) 111; K. IWATS. Mem. Coll. Sci. Univ. Kyoto B, 31 (1965) 151, 153. — Type: GAUDICHAUD, Mariana Is. (P; G).

*Aspidium uliginosum* KUNZE, Linnaea 20 (1847) 6. — *Dryopteris uliginosa* (KUNZE) C. CHR. Ind. Fil. Suppl. III (1934) 100; BACKER & POSTH. Varenfl. Java (1939) 42, p.p. — *Thelypteris uliginosa* (KUNZE) CHING, Bull. Fan Mem. Inst. Biol. Bot. 6 (1936) 342; HOLTUM, Rev. Fl. Malaya 2 (1955) 241; BROWNIE in Aubrév. Fl. Nouv. Caléd. 3 (1969) 209; MORTON, Contr. U.S. Nat. Herb. 38 (1973) 219. — Type: cult. Hort. Bot. Leipzig, origin Java (BR).

*Polypodium trichodes* HOULST. & MOORE, Gard. Mag. Bot. 3 (1851) 18; MORTON, Contr. U.S. Nat. Herb. 38 (1973) 264. — Type: cult., origin "East Indies" (BM).

*Polypodium tenericaule* HOOK. in J. Bot. Kew Misc. 9 (1857) 353. — *Lastrea tenericaulis* (HOOK.) MOORE, Ind. Fil. (1858) 99; BEDD. Handb. (1883) 266; TAGAWA, Index Pterid. Jap. (1959) 223. — *Nephrodium tenericaule* (HOOK.) HOOK. Spec. Fil. 4 (1862) 142, p.p. excl. t. 269. — Type: ALEXANDER, China (K).

*Dryopteris setigera* var. *pallida* V.A.V.R. Handb. (1908) 203; Suppl. (1917) 169. — Type: origin not specified (BO).

*Dryopteris trichodes* ROSENST. Meded. Rijksherb. Leiden 31 (1917) 6, p.p.; MORTON, Contr. U.S. Nat. Herb. 38 (1973) 265. — Lectotype (MORTON): ZOLLINGER 354, Java (L).

*Nephrodium setigerum* sensu HOOK. & BAK. Syn. Fil. (1867) 284, p.p. — *Aspidium setigerum* sensu RACIB. Fl. Buitenz. 1 (1898) 178, p.p.? — *Dryopteris setigera* sensu C. CHR., Ind. Fil. (1905) 292, p.p.; V.A.V.R. Handb. (1908) 202, p.p.; C.

CHR. Gard. Bull. Str. Settl. 7 (1934) 243. — Fig. 2h-j.

*Caudex* short-creeping. *Stipe* to 50 cm long, glaucous when young, persistent base swollen and fleshy covered with many narrow dark brown scales bearing both acicular and capitate hairs, rest of stipe and rachis smooth. *Lamina* to 70 × 50 cm, deeply tripinnatifid, pinnae 12–15 pairs, sub-basal ones longest; *largest pinnae* 20 × 9 cm, deltoid, pinnate with all pinnules but lowest adnate to a narrowly green-winged pinna-rachis; pinnules oblique to pinna-rachis, largest 5–8 × 1.5–2.5 cm, acuminate, cut almost to costa into oblique dentate to deeply lobed segments 2.5–4 mm wide, largest to 12 mm long; costae and costules bearing scattered pale slender hairs on lower surface, some of them multicellular and over 1 mm long; whole lower surface of lamina bearing short capitate hairs. *Sori* globose; indusia very small bearing a few capitate hairs; sporangia bearing 2–3 short capitate hairs.

*Distr.* Mascarene Islands; warmer parts of mainland Asia and Japan; *Malesia*; Queensland, Polynesia, Hawaii; adventive at various places in the New World from Florida southwards.

*Ecol.* In Malesia in open or lightly shaded places in low country, especially in areas with a dry season.

*NOTE.* GAUDICHAUD described this species very carefully, but his description was overlooked, and there is much confusion in the literature between this species, *M. setigera* and *M. polypodioides*. The first author to distinguish it clearly was CHING, under the name *Thelypteris uliginosa* (1936) but BACKER & POSTHUMUS (1939) ignored the distinction between *T. uliginosa* and *T. setigera*. See also note under *M. polypodioides*.

**2. *Macrothelypteris polypodioides*** (HOOK.) HOLTUM, Blumea 17 (1969) 29; Allertonia 1 (1977) 179. — *Alsophila polypodioides* HOOK. in Nightingale, Oceanic Sketches (1835) 131. —



Type: NIGHTINGALE, "South Sea Islands" (K).

*Lastrea leucolepis* PRESL, Epim. Bot. (1851) 39; COPEL. Fern Fl. Philip. (1960) 332. — *Dryopteris leucolepis* (PRESL) MAXON, Proc. Biol. Soc. Wash. 36 (1923) 172. — *Thelypteris leucolepis* (PRESL) CHING, Bull. Fan Mem. Inst. Biol. Bot. 6 (1936) 345. — *Macrothelypteris leucolepis* (PRESL) CHING, Acta Phytotax. Sinica 8 (1963) 309. — Type: CUMING 114, Luzon (PRC; BM, K).

*Cheilanthes gigantea* CESATI, Rendic. Ac. Sci. Nap. 16 (1877) 25, 29. — *Polypodium cheilanthesoides* BAK. in Beccari, Malesia 3 (1866) 45, nom. nov. (not *P. gigantea* DESV.). — *Dryopteris brunneo-villosa* C. CHR. Ind. Fil. (1905) 255, nom. nov. — *Phegopteris cheilanthesoides* (BAK.) v.A.v.R. Handb. (1908) 494. — Type: BECCARI, Mt Arfak, W. New Guinea (FI; K). — Fig. 2k-n.

*Caudex* short, prostrate; *stipe* to 80 cm long, pale, basal half at least bearing copious acicular and capitate hairs and scales; *scales* thin, pale, to 20 mm long, hardly 1 mm wide at thickened base, bearing acicular hairs on surface near base, distally on edges, old stipe covered with wart-like bases of fallen scales. *Lamina* to 80 cm long; lower pinnae to 35 × 15 cm, rest gradually smaller; lower surface of rachis (sparsely) and pinna-rachis (copiously) bearing narrow pale scales to 3 mm long, 0.3 mm wide with thickened bases and slender patent marginal hairs; *largest pinnules* 10 × 2.5 cm, almost at right angles to pinna-rachis, with tertiary leaflets connected by a very narrow wing on costa; upper surface of costa densely hairy, of costules sparsely, very narrow hair-pointed and ciliate scales on lower surface of costa grading distally to slender septate hairs; tertiary leaflets at right angles to costa, larger ones deeply lobed, capitate hairs on lower surface. *Sori* small, on acroscopic branch of a vein; indusia small, with capitate hairs; sporangia with capitate hairs.

Distr. S.E. Asia (Thailand, Taiwan), through Malesia (Philippines, New Guinea) to N.E. Australia (Queensland) and the Pacific (Cook Is., Fiji, Samoa, Tahiti, Rapa, Austral Is.).

Ecol. At low altitudes, to 700 m, on edge of forest.

Note. When writing *Species Filicum*, HOOKER suppressed his earlier name *Alsophila polypodioides* (although citing the specimen) and this was not listed by CHRISTENSEN in *Index Filicum*. This species has been much confused with the preceding and with *M. setigera*. In 1923 MAXON pointed out the distinctions between *M. polypodioides* (which he named *Dryopteris leucolepis*) and *M. torresiana* (which he named *D. setigera*).

3. *Macrothelypteris setigera* (BL.) CHING, Acta Phytotax. Sinica 8 (1963) 309; HOLTUM, Blumea 17 (1969) 31. — *Cheilanthes setigera* BL. Enum. Pl. Jav. (1828) 138. — *Dryopteris setigera* (BL.) O. KTZE, Rev. Gen. Pl. 2 (1891) 813; v.A.v.R.

Handb. (1908) 202, p.p.; Suppl. (1917) 169, excl. var. *pallida*; BACKER & POSTH. Varenfl. Java (1939) 337, p.p. — *Thelypteris setigera* CHING, Bull. Fan Mem. Inst. Biol. Bot. 6 (1936) 345. — Type: BLUME, Java (L, n. 908, 337-1168).

*Cheilanthes stenophylla* KUNZE, Bot. Zeit. 6 (1848) 212. — Type: ZOLLINGER 2675, Java (L).

*Dryopteris backeri* v.A.v.R. Bull. Dép. Agr. Ind. Néerl. 18 (1908) 8; *ibid.* 21 (1908) 3; Handb. (1908) 817; Suppl. (1917) 169, 171. — Type: BACKER, Krakatau (BO, not seen).

*Aspidium vile* (non KUNZE) RACIB. Fl. Buitenz. 1 (1898) 173. — *Dryopteris uliginosa sensu* BACKER & POSTH. Varenfl. Java (1939) 42, p.p. — Fig. 2o.

Similar to *M. polypodioides* in size and in divisions of lamina, differing in abundant scales with thickened terete bases and entire (rarely ciliate) margins on rachis and pinna-rachis. A comparison of living plants from Java and the Philippines needs to be made.

Distr. Malesia: Sumatra, Java, Lombok, Flores, Timor, S.W. Celebes, Ternate.

Ecol. In open places at medium altitudes; reported by RACIBORSKI to form extensive thickets with *Gleichenia hispida* on G. Guntur in Java. Small plants may be fertile; one such was type of *Cheilanthes stenophylla* KUNZE.

4. *Macrothelypteris multiseta* (BAK.) CHING, Acta Phytotax. Sinica 8 (1963) 309; HOLTUM, Blumea 17 (1969) 31. — *Nephrodium multisetum* BAK. J. Linn. Soc. Bot. 22 (1886) 226. — *Dryopteris multiseta* (BAK.) C. CHR. Ind. Fil. (1905) 279; v.A.v.R. Handb. (1908) 203; Suppl. (1917) 171; C. CHR. Gard. Bull. Str. Settl. 7 (1934) 243. — *Thelypteris multiseta* (BAK.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 6 (1936) 347. — Type: G. F. HOSE, G. Matang, Sarawak, 610 m (K).

*Stipe* at least 70 cm long, reddish when old; basal scales rigid, 10 × 1 mm, base thickened and edges inrolled; scales above base copious, persistent, dark, hair-pointed, entire, 5-7 mm long, hardly 0.5 mm wide, basal part terete; main rachis similarly and persistently scaly. *Pinnae* commonly 35 cm long, maximum 50 cm; pinna-rachis pale with darker spreading rigid entire scales which are almost wholly terete; pinnules commonly 8 × 1.8 cm, bearing tertiary leaflets connected by a narrow wing, axis of pinnule scaly as pinna-rachis but scales smaller, hair-pointed; tertiary leaflets lobed half-way to costule; lower surface of lamina bearing short capitate hairs. *Sori* one to each lobe of a tertiary leaflet; indusium small, with capitate hairs; sporangia with similar hairs.

Distr. Malesia: Borneo (North Borneo, Sarawak), Sumatra.

Ecol. In rather open places at 500-1250 m, sometimes abundant, but very local; only found at one place on Mt Kinabalu.

## 3. METATHELYPTERIS

(H. ITO) CHING, Acta Phytotax. Sinica 8 (1963) 304; HOLTUM, Blumea 19 (1971) 26; J.S. Afr. Bot. 40 (1974) 127; Kalikasan 5 (1976) 115. — *Thelypteris* sect. *Metathelypteris* H. ITO in Nakai & Honda, Nov. Fl. Jap. n. 4 (1939) 137; K. IWATS. Acta Phytotax. Geobot. 18 (1960) 147; Mem. Coll. Sci. Univ. Kyoto B, 31 (1965) 145, p.p. — Fig. 1m, 3.

*Caudex* short, erect or decumbent with tufted fronds; *stipes* green when living, scaly at base only, scales less than 10 mm long, narrow with a few short acicular hairs; *lamina* simply pinnate (in *M. flaccida* almost bipinnate) with deeply lobed pinnae, basal pinnae not or little reduced; veins free, often forked, with thickened ends not reaching margin; upper surface of costae prominent, not grooved; acicular and/or capitate hairs, not spherical glands, present on lower surfaces; scales on lower surface of costae, if present, uniseriate, about as in *Pseudophegopteris*; *sori* indusiate, indusia thin; sporangia sometimes with a hair of several cells on the stalk, no hairs nor glands on body; spores with irregular ridges variously united.

Type species: *Metathelypteris gracilescens* (BL.) CHING.

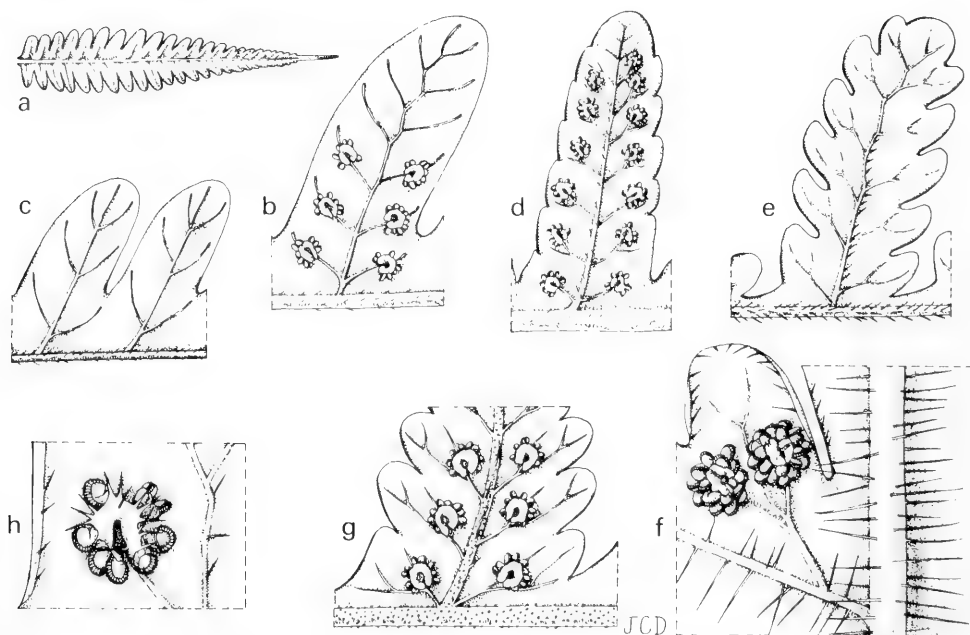


Fig. 3. *Metathelypteris gracilescens* (BL.) CHING. a. One pinna,  $\times \frac{1}{2}$ ; b. pinna-lobe, lower surface,  $\times 6$ ; c. pinna-lobe, upper surface,  $\times 6$ . — *M. dayi* (BEDD.) HOLTUM. d. Pinna-lobe,  $\times 4$ . — *M. flaccida* (BL.) CHING. e. Pinna-lobe, upper surface,  $\times 4$ ; f. lower surface,  $\times 12$ . — *M. singalanensis* (BAK.) CHING. g. Base of a pinna-lobe,  $\times 6$ . — *M. uraiensis* (ROSENST.) CHING. h. Sorus,  $\times 16$  (a-c HOLTUM 53; d DAY s.n.; e-f MATTHEW s.n.; h M. G. PRICE 3368).

Distr. Fernando Poo & S. Tomé; Nigeria (an undescribed species); Madagascar, Ceylon & India, S. China to Japan; *Malesia*; about 12 species.

Ecol. In Malesia all species occur on mountains at 1000–2000 m, usually on steep earth slopes or rocks. The only species which are both widely distributed and locally common are the tetraploid *M. dayi* and the (probably tetraploid) form of *M. flaccida* which has long hairs on the lower surface; these occur in somewhat open places, especially where paths have been made in the forest. Of the rest, *M. singalensis* is a forest fern of restricted distribution in Sumatra, *M. gracilescens* is widely distributed but rarely abundant.

Cytol. Chromosome number 35 (*M. dayi* tetraploid; *M. flaccida* diploid and tetraploid in Ceylon).

#### KEY TO THE SPECIES

1. Veins always simple except sometimes in basal acroscopic lobes of pinnae . . . 1. *M. gracilescens*
1. Veins normally forked except distal ones.
2. Pinnae with some hairs on lower surface between veins; lobes of larger pinnae lobed more than half way to costule . . . 2. *M. flaccida*
2. Pinnae not hairy between veins on lower surface; pinna-lobes entire to crenate, shallowly lobed only on largest fronds.
3. Pinnae rarely over 6 cm long; indusia bearing acicular hairs . . . 3. *M. uraiensis*
3. Pinnae of well-grown plants 12 cm or more long; indusia bearing capitate hairs.
4. Lower surface of costae and costules bearing copious capitate hairs.
5. Texture thin, drying dark green; veins conspicuously branched . . . 4. *M. singalensis*
5. Texture firm, drying yellow-green; veins forked near tips, branches little diverging
- 4b. *M. singalensis* var. *surbeckii*
4. Lower surfaces of costae and costules bearing sparse acicular hairs . . . 5. *M. dayi*

1. *Metathelypteris gracilescens* (BL.) CHING, Acta Phytotax. Sinica 8 (1963) 305; HOLTTUM, Kalikasan 5 (1976) 116. — *Aspidium gracilescens* BL. Enum. Pl. Jav. (1828) 155; RACIB. Fl. Buitenz. 1 (1898) 170. — *Lastrea gracilescens* (BL.) MOORE, Ind. Fil. (1858) 93; BEDD. Handb. (1883) 234, p.p.; Suppl. (1892) 51, p.p.; COPEL. Fern Fl. Philip. (1960) 322; TAGAWA, Col. Illus. Jap. Pterid. (1962) f. 240. — *Nephrodium gracilescens* (BL.) HOOK. Spec. Fil. 4 (1862) 93, p.p. — *Dryopteris gracilescens* (BL.) O. KTZE, Rev. Gen. Pl. 2 (1891) 812; v.A.v.R. Handb. (1908) 186 excl. syn. *Aspidium glanduligerum*; BACKER & POSTH. Varenfl. Java (1939) 38. — *Thelypteris gracilescens* (BL.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 6 (1936) 327; K. IWATS. Mem. Coll. Sci. Univ. Kyoto B, 31 (1965) 147. — Type: BLUME, Java (L).

*Nephrodium vulcanicum* BAK. Ann. Bot. 5 (1891) 127. — *Thelypteris vulcanica* (BAK.) REED, Phytologia 17 (1968) 324. — Type: HANCOCK, G. Pangerango, Java (K).

*Athyrium benguetense* CHRIST, Philip. J. Sci. 2 (1907) Bot. 161; COPEL. Philip. J. Sci. 3 (1908) Bot. 300. — Type: LOHER, Mt Data, Luzon, Feb. 1894 (not found at P).

*Dryopteris calva* COPEL. in Elmer Leaf. Philip. Bot. 3 (1910) 805. — *Dryopteris gracilescens* var. *calva* (COPEL.) C. CHR. Ind. Fil. Suppl. III (1934) 82. — *Lastrea calva* (COPEL.) COPEL. Gen. Fil. (1947) 138, Fern Fl. Philip. (1960) 323. — Type: ELMER 11485, Mt Apo, Mindanao (MICH; BM, E, K).

*Dryopteris sublaxa* HAYATA, Icon. Pl. Formos. 4 (1914) 183, f. 122. — Type: HAYATA, Mt Arisan, Taiwan, Jan. 1912 (TI, seen by IWATSUKI).

*Dryopteris arisanensis* ROSENST. Hedwigia 56 (1915) 340. — Type: FAURIE 389, Mt Arisan, Taiwan (isotype KY seen by IWATSUKI). — Fig. 3a–c.

*Caudex* short-creeping; *stipe* 18–25 cm long, pale, scales 2 mm long. *Lamina* 25–30 cm long; pinnae 15–18 pairs, rather close; basal pinnae narrowed at basiscopic base. *Largest pinnae* of type 7.5 × 1.4 cm, of type of *Nephrodium vulcanicum* 9 × 2.0 cm, short-acuminate, lobed to 1 mm from costa or more deeply, lobes entire, separated by narrow sinuses, basal acroscopic lobe of middle pinnae somewhat elongate; costules commonly 3 mm apart; veins 6–7 pairs, simple or rarely forked in basal acroscopic pinna-lobes; lower surface of rachis and costae with varied complement of short acicular and capitate hairs, sometimes almost glabrous. *Sori* medial or a little suprasedial, near tips of veins; indusia small, thin, glabrous.

Distr. S. Japan, Taiwan; Darjeeling; in *Malesia*: Malaya, Sumatra, W. Java, N. Borneo, Luzon, Mindoro, Mindanao, New Guinea.

Ecol. In Malesia at 1500–2200 m, in forest, in two cases on rocks near waterfall; only one collection from Malaya, from 1800 m at Cameron Highlands.

Note. *M. decipiens* (CLARKE) CHING, described from Darjeeling, differs in having shorter fronds with basal pinnae largest, veins mostly forked, at least in the crenate lobes of basal pinnae.

2. *Metathelypteris flaccida* (BL.) CHING, Acta Phytotax. Sinica 8 (1963) 306. — *Aspidium flaccidum* BL. Enum. Pl. Jav. (1828) 161; RACIB. Fl.

Buitenz. 1 (1898) 176. — *Lastrea flaccida* (BL.) MOORE, Ind. Fil. (1858) 92; BEDD. Ferns S. India (1864) t. 250; Handb. (1883) 244. — *Nephrodium flaccidum* (BL.) HOOK. Spec. Fil. 4 (1862) 133, t. 263. — *Dryopteris flaccida* (BL.) O. KTZE, Rev. Gen. Pl. 2 (1891) 812; v.A.v.R. Handb. (1908) 195; BACKER & POSTH. Varenfl. Java (1939) 41. — *Thelypteris flaccida* (BL.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 6 (1936) 336. — Type: BLUME, Boerangrang, Java (L., n. 908,332–1093). — Fig. 3e–f.

*Caudex* short, erect. Stipe 25–45 cm long, pale, hairy in groove only. *Lamina* 25–45 cm long; pinnae to 15 pairs, well-spaced; lowest pinnae narrowed a little on basiscopic side. *Largest pinnae* 8.5–12 × 1.8–3.5 cm, acuminate, lobed to a narrow wing on costa; lobes of largest pinnae lobed more than half way to costule, their tips blunt-pointed; costules 4–6 mm apart; veins pinnate in larger lobules of pinna-lobes, forked in smaller ones; lower surface bearing slender erect acicular hairs throughout, those on costae and costules 1 mm long in typical form (some plants in Ceylon and Malaya have hairs less than 0.5 mm). *Sori* 1–2 in each lobule of a pinna-lobe; indusia thin, pale, bearing short acicular hairs.

Distr. Ceylon & S. India, N.E. India to Yunnan, Thailand; in *Malesia*: Java, Sumatra (?), Malaya, Borneo.

Ecol. In W. Java abundant at 1500 m. In Malaya not found until in recent years plants have appeared on earth banks beside roads where forest has been cleared at Cameron Highlands and on Taiping Hills; these plants have short hairs on the lower surface of costae as in some plants found by MANTON in Ceylon.

**3. *Metathelypteris uraiensis* (ROSENST.) CHING**, Acta Phytotax. Sinica 8 (1963) 306; C. M. KUO, Fl. Taiwan 1 (1975) 419; HOLTUM, Kalikasan 5 (1976) 117. — *Dryopteris uraiensis* ROSENST. Hedwigia 56 (July 1915) 341. — *Thelypteris uraiensis* (ROSENST.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 6 (1936) 336; K. IWATS. Mem. Coll. Sci. Univ. Kyoto B, 31 (1965) 148, 152. — *Lastrea uraiensis* (ROSENST.) TAGAWA, Col. Ill. Jap. Pterid. (1962) 223. — *Macrothelypteris uraiensis* (ROSENST.) LÖVE & LÖVE, Taxon 26 (1977) 325. — Type: FAURIE 22, Urai, Taiwan (isotypes G, P).

*Dryopteris hirtisquamata* HAYATA, Icon. Pl. Formos. 5 (Nov. 1915) 277. — Type: T. ITO & FUJII, Taiwan (TI, seen by IWATSUKI). — Fig. 3h.

*Caudex* short-creeping; *stipe* c. 20 cm long, pale. *Lamina* c. 18 × 12 cm; pinnae to 18 pairs; lowest pinnae short-stalked and narrowed at base. *Largest pinnae* 4.5–6.0 cm long, 1.4–1.8 cm wide, lobed to 1 mm from costa; costules 3–4 mm apart; veins to 6 pairs, mostly forked; lower surface of costae, costules and veins bearing acicular hairs, hairs between veins sparse. *Sori* medial to supramedial, near tips of veins; indusia thin with

short acicular hairs on edge.

Distr. S. Japan, Ryukyu Islands, Taiwan, Kwangtung, Yunnan; in *Malesia*: Philippines (N. Luzon: M. G. PRICE 2915, Solsona; 3368, Mt Data, Ilocos Norte Prov.).

Note. This species is very near *M. gracilescens* but appears to be distinct in the characters mentioned in the key.

**4. *Metathelypteris singalanensis* (BAK.) CHING**, Acta Phytotax. Sinica 8 (1963) 306. — *Nephrodium singalanense* BAK. J. Bot. 18 (1880) 212. — *Lastrea singalanensis* (BAK.) BEDD. Handb. Suppl. (1892) 54. — *Dryopteris singalanensis* (BAK.) C. CHR. Ind. Fil. (1905) 293; v.A.v.R. Handb. (1908) 194. — *Thelypteris singalanensis* (BAK.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 6 (1936) 334. — Type: BECCARI 471, G. Singgalang 1700 m, Sumatra (K; FI n. 12963 in Herb. Becc.).

*Dryopteris media* v.A.v.R. Bull. Jard. Bot. Btjg II, 11 (1913) 9; Handb. Suppl. (1917) 162. — Type: MATTHEW 514, G. Singgalang, Sumatra (BO; K). — Fig. 3g.

**a. var. *singalanensis***

*Caudex* short, erect; stipe 30–50 cm long, pale; scales c. 7 mm long, narrow above widened base which is fully 1 mm wide. *Lamina* 50–70 cm long; pinnae to 25 pairs, often almost opposite, drying dark green, thin; basal pinnae not reduced. *Largest pinnae* of type 9.3 × 2.3 cm, of other specimens to 12 × 3.0 cm (fertile), 14 × 4 cm (sterile), lobed almost to costa; lobes of almost all pinnae crenate, of largest ones distinctly lobed; veins 10–12 pairs, nearly all forked, in largest lobes twice forked; lower surface of rachis, costae, costules and veins bearing copious very short capitate hairs and sometimes a few acicular hairs, some capitate hairs also on surface between veins; upper surface of rachis and costae bearing copious acicular hairs 0.2 mm long, hairs on costules minute. *Sori* on acroscopic branches of veins; indusia bearing many short capitate hairs.

Distr. *Malesia*: Central W. Sumatra (G. Singgalang).

Ecol. “on bank by path in forest” (MATTHEW); two collections from 1500 and 2100 m.

**b. var. *surbeckii* HOLTUM, var. nov.**

*A typo speciei differt: pinnis in sicco brunneo-virentibus, firmioribus; venis saepe simplicibus, versus apicem tantum breviter furcatis; pagina inferiore inter venas pilis capitatis destituta.* — Type: SURBECK 1193, Sibuatan-Zuid, Sumatra, 1700 m (L). Also ALSTON 14974, Sidikalang (BM).

Distr. *Malesia*: Central Sumatra, c. 350 km north of G. Singgalang.

**5. *Metathelypteris dayi* (BEDD.) HOLTUM** in Nayar & Kaur, Comp. to Bedd. (1974) 205; Kalikasan 5 (1976) 117. — *Aspidium dayi* BEDD. J.

Bot. 26 (1888) 4. — *Lastrea dayi* (BEDD.) BEDD. Handb. Suppl. (1892) 54. — *Dryopteris dayi* (BEDD.) C. CHR. Ind. Fil. (1905) 260; v.A.v.R. Handb. (1908) 188. — *Thelypteris dayi* (BEDD.) NAYAR & KAUR, Comp. to Bedd. (1974) 59. — Type: J. DAY, Perak, March 1887 (K).

*Nephrodium creaghii* BAK. Kew Bull. (1898) 230. — *Dryopteris creaghii* (BAK.) C. CHR. Ind. Fil. (1905) 258; v.A.v.R. Handb. (1908) 185; C. CHR. Gard. Bull. Str. Settl. 7 (1934) 240. — Type: CREAGH, N. Borneo (K).

*Dryopteris flavo-virens* ROSENST. Fed. Rep. 10 (1912) 334; v.A.v.R. Handb. Suppl. (1917) 165. — *Lastrea flavo-virens* (ROSENST.) COPEL. Gen. Fil. (1947) 138; Philip. J. Sci. 78 (1951) 423. — *Thelypteris flavo-virens* (ROSENST.) REED, Phytologia 17 (1968) 277. — Type: BAMLER W. 11 partim, Wareo, 600 m, Papua New Guinea, 11 June 1909 (S-PA).

*Dryopteris aureoviridis* ROSENST. Fed. Rep. 13 (1914) 216; v.A.v.R. Handb. Suppl. (1917) 161. — *Thelypteris aureoviridis* (ROSENST.) REED, Phytologia 17 (1968) 262. — Type: J. WINKLER 179, in terra Batacorum, Sumatra, 1911 (not seen: Ros. Fil. Sumatr. exsicc. 141 from same locality at K, L).

*Dryopteris diversivenosa* v.A.v.R. Bull. Jard. Bot. Btzg II, 28 (1918) 23. — *Thelypteris diversivenosa* (v.A.v.R.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 251. — Type: BÜNNEMEIJER 1104, Tanang Taloe, 1000 m, Ophir Distr. Sumatra (BO).

*Thelypteris singalanensis* sensu HOLTUM, Rev. Fl. Malaya 2 (1955) 243, p.p., f. 138; M. G.

PRICE, Brit. Fern Gaz. 10 (1973) 255. — Fig. 1m, 3d.

*Caudex* short, erect; plants fertile from a small size. *Stipe* 20–45 cm long, pale; basal scales very narrow, 5–7 mm long, not widened at base. *Lamina* to 50 cm long, firm, drying yellow-green; free pinnae c. 15 pairs, at least lower ones opposite; basal pinnae sometimes a little reduced, always  $\pm$  narrowed at base. *Largest pinnae* to 16  $\times$  3 cm, lobed to 1–2 mm from costa; lobes entire on small fronds, crenate to lobulate on larger ones; costules almost at right angles to costae, on larger pinnae 5–6 mm apart; veins to 10 pairs, almost all forked, basiscopic branch sometimes forked again; lower surface of rachis and base of costae glabrous, distally on costae and costules sparse acicular hairs 0.2 mm long, rarely a few short capitate hairs; hairs on upper surface of rachis 0.2 mm long, on costae 0.3 mm, on costules very short. *Sori* on acroscopic branches of veins; indusia thin with capitate hairs on edge.

*Distr.* Tonkin; Thailand; *Malesia*: Sumatra, Malaya, W. Java, Borneo, Luzon, Mindanao, New Guinea.

*Ecol.* In Malaya locally abundant at hill stations on earth banks beside paths in open or partially shaded places; in exposed places conspicuously yellow-green. One plant from Malaya cultivated at Kew was tetraploid.

*Note.* Another specimen labelled W. 11 by BAMLER (collected in 1914) was type of *Dryopteris distincta* COPEL.

#### 4. PHEGOPTERIS

FÉE, Gen. Fil. (1852) 242 *emend.* CHING, Acta Phytotax. Sinica 8 (1963) 312; HOLTUM, Blumea 17 (1969) 9. — *Polypodium* § *Phegopteris* PRESL, Tent. Pterid. (1836) 179, p.p. — *Thelypteris* subg. *Phegopteris* sect. *Phegopteris* K. IWATS. Mem. Coll. Sci. Univ. Kyoto B, 31 (1964) 25 and sect. *Lastrella* p.p.

*Caudex* wide-creeping or short and suberect; fronds pinnate with deeply lobed pinnae which are connected with each other by a wing along the rachis, the wing forming, between one pinna and the next, a  $\pm$  semicircular lobe containing a branched vein arising directly from the rachis; frond-form either deltoid or (in sole Malesian species) lanceolate with lower pinnae gradually reduced; veins in pinna-lobes simple or branched, tips of distal ones only reaching margin; sori subterminal on veins or their branches, exindusiate or with a very small indusium; sporangia often bearing short acicular or capitate hairs; lower surface of rachis and costae of pinnae copiously scaly; scales pale, thin, narrow, with slender spreading marginal hairs and a hair-tip; larger, darker and often less hairy scales present at base of stipe; surfaces of frond bearing acicular and capitate hairs.

*Type species:* *Polypodium phegopteris* L. (*Phegopteris polypodioides* FÉE).

Distr. Three species, one widely distributed in north temperate regions and south to Himalayas, one in E. North America, one in S.E. Asia.

Cytol. Base chromosome number 30: *P. connectilis* triploid; *P. hexagonoptera* diploid; *P. decursive-pinnata* diploid and tetraploid.

Notes. FÉE and other authors of the 19th century included in this genus free-veined species resembling *Nephrodium* but lacking indusia; METTENIUS admitted also species with anastomosing veins. The result in either case was an unnatural mixture. CHING was the first author to restrict the genus in the sense here accepted. The species described below differs from the type in elongate fronds on a suberect caudex.

**1. *Phegopteris decursive-pinnata*** (VAN HALL) FÉE, Gen. Fil. (1852) 242; CHING, Acta Phytotax. Sinica 8 (1963) 312; MITUI, J. Jap. Bot. 40 (1965) 119, 124; HOLTUM, Blumea 17 (1969) 11; C. M. KUO, Fl. Taiwan 1 (1975) 427, f. 148. — *Polypodium decursive-pinnatum* VAN HALL, Nieuwe Verh. Kon. Ned. Inst. Wet. 5 (1836) 204; HOOK. 2nd Cent. Ferns (1861) t. 49. — *Aspidium decursive-pinnatum* (VAN HALL) KUNZE, Bot. Zeit. 6 (1848) 555; METT. Fil. Hort. Lips. (1856) 89. — *Nephrodium decursive-pinnatum* (VAN HALL) HOOK. in Blakiston, Five Months on the Yangtse (1862) 365; DIELS in E. & P. Nat. Pfl. Fam. I, 4 (1899) 171. — *Leptogramma decursive-pinnata* (VAN HALL) J. Sm. Hist. Fil. (1875) 232. — *Dryopteris decursive-pinnata* (VAN HALL) O. Ktze Rev. Gen. Pl. 2 (1891) 812; v.A.v.R. Handb. Suppl. (1917) Corr. 48; Bull. Jard. Bot. Btzg II, 28 (1918) 23. — *Thelypteris decursive-pinnata* (VAN HALL) CHING, Bull. Fan Mem. Inst. Bot. 6 (1939) 275; K. IWATS. Mem. Coll. Sci. Univ. Kyoto B, 31 (1965) 137. — Type: South China ex Herb. VAN HALL (L).

*Lastrea decurrens* J. Sm. in Curt. Bot. Mag. 72 (1846) Comp. 32. — Type: CAMERON, China (BM).

*Caudex* short, suberect; *stipes* tufted, 3–10 cm long, closely scaly and hairy throughout; scales at base firm, brown with copious stiff marginal hairs; *lamina* to 50 cm long, narrowed gradually to apex and base; lowest pinnae 10–15 mm long, middle pinnae 3.5–8 cm long, 6–10 mm wide, lobed  $\frac{1}{2}$ – $\frac{3}{4}$

towards costa; veins in lobes pinnate, veinlets simple; sori subterminal on veinlets, to 8 on larger lobes; indusium very small, bearing long stiff unicellular hairs; sporangia bearing either acicular or capitate hairs.

Distr. Central & S.E. China, Tonkin, Taiwan, Korea; in *Malesia* recorded from Celebes and East Java.

Ecol. In Taiwan, at low and median altitudes, usually on rocks (C. M. KUO).

Notes. At Paris is a specimen of ZOLLINGER 1442 named *Asplenium erectum* WILLD., ex Herb. DRAKE, from East Java, "ad pedem Mt Lamongan 1500', Jan. 1845". v.A.v.R. records a cultivated plant at Bogor originating from Celebes, collected there by KOORDERS. These are the only known records of the occurrence of the species in *Malesia*.

A small indusium was first described by J. SMITH in *Lastrea decurrens*. CHING and IWATSUKI have stated that the receptacle bears a tuft of hairs, not an indusium; but there is a distinct flat structure with hairs on its margin which I would not call part of the receptacle.

MITUI has recorded diploid and tetraploid conditions in the species, but no-one has distinguished the two forms from other characters, and I cannot see clear distinctions among herbarium specimens.

For some years a plant flourished in cultivation in the Botanic Garden at Penang but did not reproduce itself from spores. Plants grow well in the Temperate Fern-House at Kew.

## 5. CORYPHOPTERIS

HOLTUM, Blumea 19 (1971) 33; Blumea 23 (1976) 18–47; Allertonia 1 (1977) 195. — *Parathelypteris* sect. *Melanostipes* CHING, Acta Phytotax. Sinica 8 (1963) 301, p.p. — Fig. 11, 4.

*Caudex* erect, to c. 30 cm tall except in *C. inopinata*; *stipes* dark throughout or paler distally, in a few cases bearing spreading septate hairs near base, always with rather broad scales which in most species lack acicular hairs. *Lamina* commonly 20–40 cm long, rarely to 80 cm, apex never pinna-like; lowest pinnae not or little reduced except in *C. fasciculata* and *C. squamipes*, narrowed towards their bases and often wider at their middle than other pinnae; basal acroscopic lobe often enlarged and dentate

with some forked veins; aerophores at bases of pinnae somewhat swollen; *pinnae* always deeply lobed, one or more basal lobes sometimes free; veins in lobes simple or rarely once forked, both basal veins to edge above base of sinus; lower surface of rachis, costae, costules and veins always bearing some reduced scales (smallest filiform); spreading acicular hairs usually present on lower surface of axes of frond (sometimes replaced by short capitate hairs), in some cases longer hairs which may be septate; sessile resinous glands (which may collapse on drying) present on lower surfaces of many species, in some also on upper surface; costa always grooved on upper surface; hairs on upper surface of rachis and costae always acicular, normally unicellular, in a few species septate. *Sori* usually with rather large indusia which may be glandular or hairy, distal sori (rarely all) sometimes asymmetric as in *Athyrium*; sporangia short-stalked, never with glands or hairs on body, sometimes with a sessile gland on the stalk; spores usually pale, translucent, with a  $\pm$  continuous wing and a few cross-wings, in at least one species with many small wings.

Type species: *Coryphopteris viscosa* (BAKER) HOLTUM.

Distr. N.E. India to S. China and Japan; *Malesia* (except Java and Lesser Sunda Islands), Solomon Islands, New Caledonia, Fiji, Samoa, Tahiti, Rapa, Marquesas; in all about 47 species.

Cytol. In HOLTUM, *Ferns of Malaya* (1955) p. 624, MANTON recorded  $n=32$  for *Thelypteris pectiniformis* (fig. 8) and  $2n=c. 70$  for *T. viscosa*; the latter record was probably made from a plant of the species later named *Coryphopteris arthrotricha* HOLTUM. In June 1980 J. W. GRIMES examined a plant of *C. arthrotricha*, from Cameron Highlands, Malaya, in cultivation at Kew, and found  $n=66$ , indicating a tetraploid with base number 33. This number had not previously been recorded for any species in the family. There are no other records of observations on the chromosomes of this genus. It seems possible that the count of  $n=32$  for *C. pectiniformis* might have been an error for 33, as the photograph in fig. 8 shows some overlapping of chromosomes. Counts from other species are needed to confirm that  $n=33$  is characteristic of the genus.

Ecol. Plants of this genus occur only in  $\pm$  mossy forest on mountain ridges where the soil is leached and often peaty; Mrs A. G. PIGGOTT reports a pH of 4.0 for soil on G. Ulu Kali in Malaya (Fern Gaz. 11, 1978, 428). In this habitat there are usually no other thelypteroid ferns.

Notes. The greatest number of species (20) occur in New Guinea, where there is the greatest and most varied development of suitable mountainous country.

Critical new field work is needed everywhere for a better understanding of this genus; more new species may remain to be discovered, and some here described need to be more clearly characterized. The presence and distribution of glands is always a significant character, as in other members of the family. The glands of *Coryphopteris* are resinous and sometimes collapse when dried by artificial heat or when treated with alcohol before drying; in the collapsed state they are often difficult to see.

Among species lacking glands, the only one widely distributed is *C. badia*. This appears to be peculiar in growing always in moss-cushions, sometimes on branches of trees. The bases of stipes are covered with slender hairs like those on roots and probably have the same function.

Species 1-3 have hairs of a different type at the bases of stipes; these are rigid and spreading, consisting of many cells. Habitat conditions for these species have not been well recorded. One of them is *C. unidentata* which has larger fronds than any other in the genus and is only known from three mountains in the north of Malaya. *C. arthrotricha*, the common species on the Main Range of Malaya, has septate hairs on the upper surface of costae, not at the base of stipes; *C. tahananensis*, only known from Gunung Tahan in Malaya, is intermediate between *C. multisora* of Borneo and *C. arthrotricha*.

The almost invariable miniature arborescent habit of well-grown plants of all species of this genus, and the fact that they are confined to ridge-tops where other thelypteroid ferns will not grow, suggests that *Coryphopteris* may be the relic of a primitive section of the family. The *Cyathea*-like septate hairs on upper surface of rachis and costae in *C. unidentata*, *C. hirsutipes*, *C. multisora*, *C. tahananensis* and *C. arthrotricha* may also be a relic of a primitive condition. The only species which show a partially bipinnate condition are *C. habbemensis* and *C. stereophylla*, both much smaller in stature than *C. unidentata*.

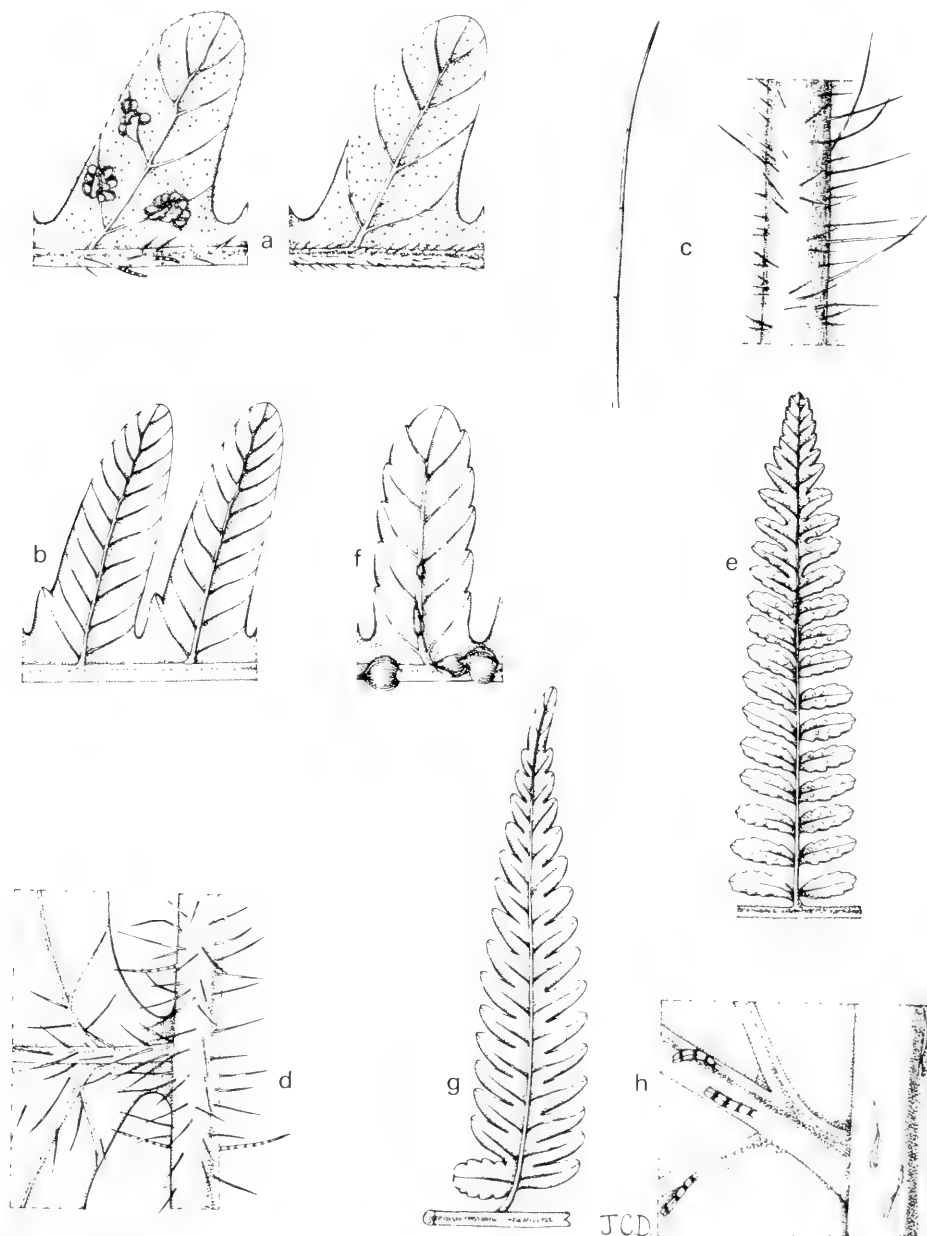


Fig. 4. *Coryphopteris viscosa* (BAK.) HOLTUM. a. Lower and upper surface of pinna-lobes, showing glands, hairs and uniseriate scales,  $\times 8$ . — *C. unidentata* (BEDD.) HOLTUM. b. Middle lobes of basal pinna,  $\times 3$ . — *C. hirsutipes* (CLARKE) HOLTUM. c. Base of stipe,  $\times 8$  and part of one hair,  $\times 32$ . — *C. multisora* (C. CHR.) HOLTUM. d. Rachis and base of pinna, lower surface, showing septate hairs,  $\times 8$ . — *C. habbemensis* (COPEL.) HOLTUM. e. One pinna,  $\times 1.5$ . — *C. klossii* (RIDL.) HOLTUM. f. One pinna-lobe,  $\times 6$ . — *C. badia* (v.A.v.R.) HOLTUM. g. Basal pinna,  $\times 1.5$ ; h. costa and part of costule, showing acicular hairs and narrow scales,  $\times 40$  (a PIGGOTT 1896, b KUNSTLER 7434, c-d MOYSEY s.n., e PULLEN 5248, f VINK 17207, g-h MATTHEW s.n.).



## KEY TO THE SPECIES

1. Base of stipe bearing pale, firmly cylindrical multiseptate hairs.
2. Stipe and abaxial surface of rachis densely covered with spreading hairs many of which are septate (see also n. 14) . . . . . **1. *C. unidentata***
2. Stipe above base and abaxial surface of rachis less densely hairy with few septate hairs.
3. Indusium glandular; scales at base of stipe to  $10 \times 3$  mm . . . . . **2. *C. multisora***
3. Indusia bearing acicular hairs; scales at base of stipe much smaller . . . . . **3. *C. hirsutipes***
1. Base of stipe not bearing such hairs.
4. Sessile glands and/or acicular hairs abundant between veins on upper surface.
5. Scales on lower surface of costae at most 2 cells wide at base.
6. Stipe-scales thin, less than 1 mm wide above base; lower surface of costae bearing many acicular hairs.
7. Pinnae to 2.5 cm long, nearly all deflexed . . . . . **4. *C. plumosa***
7. Pinnae to 5.5 cm long, a few basal ones deflexed.
8. Pinnae to 25 pairs or more; pinna-lobes mostly entire . . . . . **5a. *C. viscosa* var. *viscosa***
8. Pinnae 12–18 pairs; pinna-lobes mostly crenate . . . . . **5b. *C. viscosa* var. *poiensis***
6. Stipe-scales firm, 1 mm or more wide; lower surface of costae bearing short capitate hairs and glands, acicular hairs lacking or very few.
9. Upper surface of pinnae lacking acicular hairs between veins **6a. *C. gymnopoda* var. *gymnopoda***
9. Upper surface of pinnae bearing acicular hairs between veins.
10. Lower surface between veins, and indusia, lacking acicular hairs **6b. *C. gymnopoda* var. *bintangensis***
10. Lower surface bearing copious short erect acicular hairs between veins **6c. *C. gymnopoda* var. *humilis***
5. Scales on lower surface of costae widened at base.
11. Upper surface of pinnae lacking acicular hairs between veins.
12. Scales on lower surface of costae broadly ovate . . . . . **7. *C. klossii***
12. Scales on lower surface of costae linear with a  $\pm$  widened base.
13. Indusia bearing copious acicular hairs; stipe-scales  $3 \times 0.8$  mm, firm, with many spherical outgrowths on dorsal surface . . . . . **8. *C. iwatsukii***
13. Indusia lacking acicular hairs; stipe-scales to  $7 \times 1.5$  mm, thin, smooth dorsally **9. *C. atjehensis***
11. Upper surface of pinnae bearing acicular hairs between veins . . . . . **10. *C. obtusata***
4. Sessile glands and acicular hairs lacking or rare between veins on upper surface of pinnae.
14. Sessile glands present on lower surface generally, or at least on costules.
15. Sori distinctly supramedial . . . . . **11. *C. diaphana***
15. Sori medial to inframedial.
16. Basal half of lower pinnae bearing free or separately adnate pinnules . . . . . **12. *C. habbemensis***
16. At most one free pinnule present at base of largest pinnae.
17. Many septate hairs present on upper surface of rachis and costae.
18. Septate hairs on upper surface of rachis and costae less than 0.5 mm long; stipe-scales 3 mm long . . . . . **13. *C. arthrotricha***
18. Septate hairs on upper surface of rachis and costae 1 mm or more long; stipe-scales much longer.
19. Stipe-scales to  $10 \times 3$  mm, thin; hairs on upper surface of rachis and costae commonly 1–1.5 mm long . . . . . **2. *C. multisora***
19. Stipe-scales to  $7 \times 1$  mm, rigid, hair-pointed; hairs on upper surface of rachis and costae not over 1 mm long . . . . . **14. *C. tahanensis***
17. Septate hairs absent or rare on upper surface of rachis and costae.
20. Sori mainly along one side of a vein, rarely reniform . . . . . **15. *C. athyrioides***
20. Sori mainly reniform, distal ones sometimes  $\pm$  athyrioid.
21. All pinna-lobes entire.
22. Pinnae thin, copiously hairy on costae beneath; costal scales few.
23. Hairs on lower surface of costae unicellular . . . . . **16. *C. pectiniformis***
24. Pinnae c. 1.6 cm. wide; veins 7–8 pairs; hairs on lower surface of costae over 0.5 mm long . . . . . **16a. *C. pectiniformis* var. *pectiniformis***
24. Pinnae c. 0.8 cm wide, veins 3–4 pairs; hairs on lower surface of costae c. 0.1 mm long **16c. *C. pectiniformis* var. *minor***
23. Hairs on lower surface of costae to 1.5 mm long, septate **16b. *C. pectiniformis* var. *hirsuta***
22. Pinnae rigid; costae sparsely hairy beneath and bearing many small scales **17. *C. andersonii***

21. At least basal acroscopic lobes of middle pinnae dentate.
25. Lamina to 15 cm long; largest pinnae  $3.0 \times 0.8$  cm . . . . . 18. *C. andreae*
25. Lamina always much longer; pinnae in most cases to at least  $5 \times 1$  cm.
26. Lower pinnae, at least 2 pairs, reduced; basal pinnae not wider than next above them.
27. Six or more pairs lower pinnae gradually reduced; lowest 1.5–2 cm long; stipe commonly to 15 cm long . . . . . 19. *C. squamipes*
27. 2–4 pairs lower pinnae reduced, lowest larger; stipe 20–25 cm.
28. Fertile pinnae to  $4.5 \times 1.2$  cm; stipe-scales to 2.5 mm wide . . . . . 20. *C. borealis*
28. Fertile pinnae to  $8.5 \times 1.7$  cm; stipe-scales 1 mm wide . . . . . 21. *C. meibasis*
26. Basal pinnae wider and not shorter than those next above them.
29. Basal acroscopic lobe of basal pinnae free.
30. Glands on lower surface usually confined to costules and veins; no hairs between veins on upper surface.
31. Lamina to 25 cm long; pinnae 12–15 pairs . . . . . 22a. *C. pubirachis* var. *pubirachis*
31. Lamina to 40 cm long; pinnae to 20 pairs . . . . . 22b. *C. pubirachis* var. *major*
30. Glands present between veins on lower surface and hairs between veins on upper surface.
32. Basal pinnae to  $9 \times 2$  cm; most pinna-lobes almost entire . . . . . 22c. *C. pubirachis* var. *philippinensis*
32. Basal pinnae to  $6 \times 1.2$  cm; most pinna-lobes dentate or crenate . . . . . 22d. *C. pubirachis* var. *sulawesica*
29. Basal acroscopic lobe of basal pinnae not free.
33. Stipe-scales less than 1 mm wide above dilated base.
34. Pinnae to 18 pairs; lower surface of rachis bearing capitate hairs only; many capitate hairs between veins on upper surface . . . . . 23. *C. athyriocarpa*
34. Pinnae to 25 pairs; lower surface of pinna-rachis bearing acicular hairs; no hairs between veins on upper surface . . . . . 5c. *C. viscosa* var. *borneensis*
33. Stipe scales at least 1 mm wide above base.
35. Pinna-lobes, except basal one, entire; glands present between veins on lower surface . . . . . 17. *C. andersonii*
35. Pinna-lobes all distinctly dentate; no glands between veins on lower surface . . . . . 24. *C. tanggamensis*
14. Sessile glands lacking on lower surface except in *C. fasciculata* which may have a few glands on costae.
36. Indusia lacking . . . . . 25. *C. engleriana*
36. Indusia present.
37. Several pairs of free pinnules on lower pinnae . . . . . 26. *C. stereophylla*
37. At most basal lobes free.
38. Upper surface bearing hairs between veins.
39. Hairs on upper surface between veins acicular.
40. Stipe bearing copious hairs 1 mm long . . . . . 27. *C. horizontalis*
40. Stipe bearing hairs 0.5 mm long in groove only . . . . . 28. *C. microlepigera*
39. Hairs on upper surface between veins capitate . . . . . 29. *C. propria*
38. Upper surface between veins normally glabrous.
41. Lower surface of rachis bearing acicular hairs, costae usually also.
42. Some hairs on upper surface of costae septate . . . . . 30. *C. lauterbachii*
42. Hairs on upper surface of costae unicellular.
43. Several pairs lower pinnae gradually reduced, longest 5.5 cm, lowest 1–2 cm . . . . . 31. *C. fasciculata*
43. Lower pinnae not or little reduced.
44. Texture rigid; pinnae to 3 cm long; hairs on lower surface of rachis 0.5 mm long . . . . . 32. *C. hubrechtensis*
44. Texture thin; pinnae to 6.5 cm long; hairs on lower surface of rachis 0.2 mm long . . . . . 33. *C. brevopilosa*
41. Lower surface of rachis and costae lacking (or almost lacking) acicular hairs.
45. Short capitate hairs present on lower surface of costae and costules and on indusia . . . . . 34. *C. oligolepia*
45. Capitate hairs lacking or rare on lower surface and indusia.
46. Sori supramedial; stipe-scales 8–10 mm long . . . . . 35. *C. coriacea*
46. Sori medial or inframedial; stipe-scales not over 5 mm long.
47. Sori mostly athyroid; pinnae to 2.5 cm long . . . . . 36. *C. ledermannii*

47. Sori mostly not athyroid; pinnae longer.  
 48. Caudex erect.  
 49. Pinnae thin; no tangled hairs at base of stipe.  
 50. Veins 3–4 pairs; pinna-lobes entire except basal acroscopic ones . . . . . 37. *C. dura*  
 51. Veins c. 6 pairs; pinna-lobes mostly crenate.  
 51. Pinnae caudate-acuminate . . . . . 38. *C. platyptera*  
 51. Pinnae short-acuminate . . . . . 39. *C. subnigra*  
 49. Pinnae thick; tangled hairs often present at base of stipe . . . . . 40. *C. badia*  
 48. Caudex slender, long-creeping . . . . . 41. *C. inopinata*

**1. *Coryphopteris unidentata* (BEDD.) HOLTUM**, Blumea 23 (1976) 26. — *Lastrea unidentata* BEDD. Handb. Suppl. (1892) 53. — *Dryopteris monodonta* C. CHR. Ind. Fil. (1905) 278, *nom. nov.*; C. CHR. Gard. Bull. Str. Settl. 4 (1929) 388. — *Thelypteris unidentata* (BEDD.) HOLTUM, Rev. Fl. Malaya 2 (1955) 251. — Type: KUNSTLER 7434, Gunung Bubu, Perak (K). — Fig. 4b.

Stipe to 60 cm long, bearing throughout spreading septate hairs 1 mm or more long; basal scales  $10 \times 1.5$  mm. Lamina to 80 cm long; pinnae c. 25 pairs; basal pinnae narrowed at base, basal acroscopic lobe enlarged, dentate, free, some other lobes with a single tooth at basiscopic base; largest pinnae  $18.5 \times 2.6$  cm, sessile, lobed to 1 mm from costa, lobes entire except basal ones; costules to 5 mm apart; veins to 10 pairs; lower surface of rachis and costae bearing septate hairs; sessile glands present on costae, costules and veins, fewer between veins, narrow scales on costae and costules; upper surface of costae bearing septate hairs, few on costules, no glands. Sori medial; indusia bearing short capitate hairs or glands.

Distr. *Malesia*: Malaya. Only known from G. Bubu, G. Bintang and G. Inas in Perak.

Note. The presence of a single large tooth at the basiscopic base of lobes of basal pinnae, which is denoted by the name *unidentata*, occurs only on the type collection. The others are smaller (the smallest frond has pinnae to  $12 \times 1.8$  cm) but otherwise do not differ. The septate hairs at base of stipe are shorter than those on *C. hirsutipes*.

**2. *Coryphopteris multisora* (C. CHR.) HOLTUM**, Blumea 23 (1976) 26. — *Dryopteris multisora* C. CHR. Gard. Bull. Str. Settl. 7 (1934) 241. — *Thelypteris multisora* (C. CHR.) REED, Phytologia 17 (1968) 295. — Type: HOLTUM 25523, Sabah, Mt Kinabalu 2100 m (BM; BO, SING). — Fig. 4d.

Stipe to 45 cm, dark bearing sessile glands throughout and long septate hairs near base, also distally in the groove; scales thin, to  $10 \times 3$  mm. Lamina to 55 cm long; pinnae to 25 pairs; basal pinnae to 2.1 cm wide in middle, narrowed to base with basal acroscopic lobe enlarged, dentate to deeply lobed, almost free, rarely to 15 mm long. Pinnae above base to  $11 \times 1.8$  cm, acuminate; lobes not falcate, entire or nearly so; costules 3.5–4 mm apart; veins 6–7 pairs; glands present on

lower surface of rachis, costae and costules, sparse septate hairs on rachis and costae (sometimes absent), many very narrow scales on costae and costules; upper surface of rachis bearing septate hairs 1–1.5 mm long, similar but shorter hairs on costae and costules; sometimes a few glands on costae and costules. Sori large, somewhat in-framedial, filling lower surface at maturity; indusia glandular.

Distr. *Malesia*: Sabah (Mt Kinabalu), Sarawak (G. Mulu), 1350–3000 m, several collections.

Note. Long septate hairs are not present at the base of stipes in all specimens; the species therefore appears in two places in the key. CHRISTENSEN wrongly stated that glands are absent from lower surface of rachis and costae.

**3. *Coryphopteris hirsutipes* (CLARKE) HOLTUM** in Nayar & Kaur, Comp. to Bedd. (1974) 203; Blumea 23 (1976) 27. — *Nephrodium gracilescens* var. *hirsutipes* CLARKE, Trans. Linn. Soc. II Bot. 1 (1880) 514, t. 67, f. 1. — *Lastrea gracilescens* sensu BEDD. Handb. (1883) 234, p.p. — *Lastrea hirsutipes* (CLARKE) BEDD. Handb. Suppl. (1892) 52, *excl. var. didymochlaenoides*. — *Thelypteris hirsutipes* (CLARKE) CHING, Bull. Fan Mem. Inst. Biol. Bot. 6 (1936) 314. — *Parathelypteris hirsutipes* (CLARKE) CHING, Acta Phytotax. Sinica 8 (1963) 303. — Lectotype (HOLTUM 1976): CLARKE 18968, Assam, Khasya Hills 1400 m (K).

*Dryopteris indochinensis* CHRIST in Morot J. Bot. 21 (1908) 263. — *Thelypteris indochinensis* (CHRIST) CHING, Bull. Fan Mem. Inst. Biol. Bot. 6 (1936) 327; TARD. & C. CHR. Fl. Gén. I-C 7, pt. 2 (1941) 361, f. 43, 1–2. — *Parathelypteris indochinensis* (CHRIST) CHING, Acta Phytotax. Sinica 8 (1963) 304. — Type: EBERHARDT, Tonkin, Massif du Tam Dao, 900 m (P).

*Dryopteris gracilescens* (Bl.) O. KTZE var. *chinensis* CHRIST, Not. Syst. 1 (1909) 40. — Type: HENRY 10111, Yunnan (P; K).

*Dryopteris megalocarpa* v.A.v.R. Bull. Jard. Bot. Btzig III, 5 (1922) 199. — *Thelypteris megalocarpa* (v.A.v.R.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 252. — Type: LÖRZING 7134, Sumatra, Patjoer-batoo near Lake Toba (BO).

*Thelypteris angulariloba* CHING, Bull. Fan Mem. Inst. Biol. Bot. 6 (1936) 323; K. IWATS. Mem. Coll. Sci. Univ. Kyoto B, 31 (1965) 160. —

*Parathelypteris angulariloba* (CHING) CHING, Acta Phytotax. Sinica 8 (1963) 304; C. M. KUO, Fl. Taiwan 1 (1975) 421, pl. 145. — *Wagneriopteris angulariloba* (CHING) LÖVE & LÖVE, Taxon 26 (1977) 325. — Type: N. K. CHUN 42644, Kwangtung (PE, not seen).

*Thelypteris simozawae* TAGAWA, Acta Phytotax. Geobot. 6 (1937) 157. — *Parathelypteris simozawae* CHING, Acta Phytotax. Sinica 8 (1963) 304. — Type: SIMOZAWA, Taiwan, 17 Oct. 1936 (KYO, not seen).

*Thelypteris herbacea* HOLTUM, Gard. Bull. Sing. 11 (1947) 268; Rev. Fl. Mal. 2 (1955) 254, f. 145. — Type: HOLTUM 20571, Malaya, Gunung Tahan, 915 m (SING; K). — Fig. 4c.

Stipe 20–30(–45) cm long, dark at base only, distal part and rachis pale reddish, at base spreading septate hairs 1–3 mm long; scales small, setose. Lamina 25–35 cm long, pinnae 15–20 pairs; basal pinnae narrowed near base, basal acroscopic lobe almost free but not elongate; texture thin. Largest pinnae commonly 7 × 1.5 cm (to 10 × 2 cm), acuminate, lobes oblong, entire or sometimes slightly toothed at ends of distal veins; costules 3.5–4.5 mm apart; veins 4–6 pairs; lower surface of rachis and costae bearing copious acicular hairs which are sometimes unicellular (types of *L. hirsutipes*, *D. megalocarpa*, *T. herbacea*) but sometimes few or many are elongate and septate; glands on lower surface absent or few (types of *L. hirsutipes* and *T. herbacea*), rarely abundant; some hairs on upper surface of rachis and costae always septate, slender unicellular hairs often present between veins. *Sori* medial or inframedial; indusia hairy, hairs sometimes septate.

Distr. S. Japan, Ryukyu Islands, Taiwan, S. China to N.E. India, Thailand; in Malesia: Malaya, Sumatra.

Notes. IWATSUKI discussed the variability of this species under *T. angulariloba*. I have not seen CHING's type of this, but at Kew are two specimens from Hong Kong cited by him; these and others from Hong Kong and Kwangtung show much variability in abundance of long septate hairs on lower surface, though these hairs are always less abundant than in the type of *D. indochinensis*. CHING stated that the type of *T. angulariloba* lacked glands, but some Hong Kong specimens (including one cited by CHING) have a few. Sumatran specimens are varied both in presence of glands and of septate hairs on lower surface.

4. *Coryphopteris plumosa* (C. CHR.) HOLTUM, Blumea 23 (1976) 28. — *Dryopteris plumosa* C. CHR. Dansk Bot. Ark. 9, 3 (1937) 65. — *Thelypteris plumosa* (C. CHR.) REED, Phytologia 17 (1968) 305. — Type: Mjöberg 7, Sarawak, Mt Murud 2700 m (BM).

Stipe 6–10 cm, base very dark with copious reddish firm scales 7 × 0.7 mm, upper part paler

and finely short-hairy; rachis almost stramineous. Lamina 20 cm long, pinnae nearly 30 pairs, nearly all deflexed, middle ones largest; basal pinnae 2 cm long, slightly narrowed on basicopic base, basal acroscopic lobe a little enlarged, dentate and free, texture firm. Largest pinnae 2.5 × 0.8 cm, lobes entire; costules 2 mm apart; veins 3–4 pairs, pale and prominent both sides; lower surface of rachis and costae bearing pale acicular hairs more than 0.5 mm long, small capitate hairs present on costae, costules and veins, some glands between veins, a few very narrow scales on costae; upper surface of costae hairy as lower, veins and costules with small capitate hairs, glands throughout. *Sori* supramedial; indusia small, thin, with capitate hairs.

Distr. Malesia: Borneo (Sarawak), only known from the type.

5. *Coryphopteris viscosa* (BAK.) HOLTUM, Blumea 19 (1971) 33; Blumea 23 (1976) 29. — *Lastrea viscosa* J. SM. in Hook. J. Bot. 3 (1841) 412, nom. nud. — *Nephrodium calcaratum* (BL.) HOOK. Spec. Fil. 4 (1862) 93, var. *B. tantum*. — *Nephrodium viscosum* BAK. Syn. Fil. (1867) 264, excl. plant. Philip. — *Lastrea viscosa* (BAK.) BEDD. Ferns Br. India (1870) t. 334; Handb. (1883) 238; RIDL. J. Mal. Br. R. As. Soc. 4 (1926) 65, p.p.; COPEL. Fern Fl. Philip (1960) 324, excl. plant. Philip. — *Dryopteris viscosa* (BAK.) O. KTZE, Rev. Gen. Pl. 2 (1891) 814; v.A.v.R. Handb. (1908) 186, p.p.; C. CHR. Gard. Bull. Str. Settl. 4 (1929) 380, p.p.; *ibid.* 7 (1934) 240, p.p. — *Thelypteris viscosa* (BAK.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 215; HOLTUM, Rev. Fl. Mal. 2 (1955) 252, p.p. — *Parathelypteris viscosa* (BAK.) CHING, Acta Phytotax. Sinica 8 (1963) 304. — Type: CUMING 401, Malacca, Mt Ophir (K; BM). — Fig. 11, 4a.

#### a. var. *viscosa*

Stipe 15–20 cm long, dark at base, paler upwards, basal scales 4 × 0.5 mm, thin; rachis dull reddish throughout. Lamina to 30 cm long, tapering very gradually distally, thin, pinnae 25 pairs or more, closely placed, a few lower ones deflexed; basal pinnae to 1.4 cm wide, narrowed to base, basal acroscopic lobe little or not dentate, not free. Largest pinnae 5.5 × 1.2 cm, sessile; base truncate with acroscopic lobe sometimes a little elongate; apex short-pointed, obtuse; lobes mostly entire; costules 2.5 mm apart; veins to 6 pairs; lower surface of rachis and costae bearing copious acicular hairs 0.5 mm long with some short capitate hairs and glands; scales on costae 1–2 cells wide; glands abundant between veins; glands throughout upper surface. *Sori* medial, distal ones ± athyroid; indusia thin, with a few glands.

Distr. Malesia: Malaya (Mt Ophir), Borneo (Sarawak: Mt Poi).

**b. var. *poiensis*** HOLTUM, *Blumea* 23 (1976) 29. — Type: BURTT & WOODS 2828, Poi Range (K).  
Pinnae 12–18 pairs, pinna-lobes mostly crenate.  
Distr. *Malesia*: Borneo (Sarawak: Poi Ra.), several collections.

**c. var. *borneensis*** HOLTUM, *Blumea* 23 (1976) 29. — Type: RICHARDS 1702, Sarawak, Mt Dulit (K).

Upper surface of pinnae lacking glands.

Distr. *Malesia*: Borneo (Sarawak: Mt Dulit, several collections; G. Mulu; Mt Penrissen; Kalimantan: Mt Bengkaram).

**6. *Coryphopteris gymnopoda*** (BAK.) HOLTUM, *Blumea* 23 (1976) 29. — *Nephrodium gymnopodum* BAK. Trans. Linn. Soc. Bot. 4 (1894) 252. — *Dryopteris gymnopoda* (BAK.) C. CHR. Ind. Fil. (1905) 269; Gard. Bull. Str. Settl. 7 (1934) 240. — Type: HAVILAND 1486, Mt Kinabalu 3200 m (K).

*Lastrea ridleyi* BEDD. Kew Bull. (1909) 423. — *Dryopteris ridleyi* (BEDD.) C. CHR. Ind. Fil. Suppl. (1913) 38. — Type: RIDLEY 7849, Selangor, Bukit Hitam, 1000 m (K).

*Dryopteris subviscosa* v.A.v.R. Bull. Jard. Bot. Btzg II, 26 (1915) 14; Handb. Suppl. (1917) 153. — Type: BECCARI 429, Sumatra, G. Singgalang 1700 m (BO; FI, K).

*Dryopteris kinabaluensis* COPEL. Philip. J. Sci. 12 (1917) Bot. 55. — Type: TOPPING 1719, Mt Kinabalu (Am. Fern Soc. Ann Arbor, not seen).

*Lastrea robinsonii* RIDL. J. Fed. Mal. St. Mus. 10 (1920) 156; J. Mal. Br. R. As. Soc. 4 (1926) 65, p.p. — *Dryopteris robinsonii* (RIDL.) C. CHR. Gard. Bull. Str. Settl. 4 (1929) 381. — *Thelypteris robinsonii* (RIDL.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 254. — Type: F. M. Mus. Collector, Perak, G. Kerbau (K).

*Dryopteris viscosa* var. *kamborangana* C. CHR. Gard. Bull. Str. Settl. 7 (1934) 240. — HOLTUM 25472, Mt Kinabalu 2130 m (BM; BO, K, SING).

*Thelypteris viscosa* sensu HOLTUM, Rev. Fl. Mal. 2 (1955) 252, p.p.

**a. var. *gymnopoda***

Stipe 15–20 cm long; scales 6–8 × 1–1.5 mm, dark, firm, bases not dilated. *Lamina* 25–30 cm long; pinnae 15–18 (rarely to 25) pairs, texture firm, well spaced; lowest pinnae wider than next, in largest fronds more than 2 cm wide with almost all lobes dentate, in smaller fronds lobes crenate. *Suprabasal pinnae* commonly 6 × 1.5 cm, on largest fronds 10 × 2 cm, acuminate to subcaudate, lobes mostly crenate; costules 3–3.5 mm apart; veins 6–7(–9) pairs; lower surface of rachis bearing some acicular hairs, of costae bearing many glands and capitate hairs, sometimes a few acicular hairs, scales all linear, 1–2 cells wide, glands present throughout lower surface; acicular hairs on upper surface of rachis and costae 0.5 mm long, few on costules and veins distally; abundant

glands throughout. *Sori* medial, basal ones sometimes a little elongate and asymmetric, distal ones rarely athyroid; indusia bearing short capitate hairs and glands.

Distr. Peninsular Thailand, in *Malesia*: Sabah (Mt Kinabalu, many collections), Sarawak; in Malaya on Gunung Tahan and at scattered localities on the Main Range, perhaps only in rather open places; Sumatra, Peninsular Thailand.

Notes. The type is a single small frond which has lost almost all its scales but owing to the many other collections its identity is not in doubt. Peninsular specimens have narrower scales than Bornean ones. *Lastrea ridleyi* and *L. robinsonii* appear to differ only in their small size.

**b. var. *bintangensis*** HOLTUM, *Blumea* 23 (1976) 30. — Type: C. B. KLOSS, G. Bintang on Kedah-Perak boundary, June 1917 (K).

Upper surface between veins bearing a variable number of appressed acicular hairs 0.3–0.5 mm long.

**c. var. *humilis*** HOLTUM, *Blumea* 23 (1976) 30. — Type: MOLESWORTH ALLEN 1026, Pahang, Cameron Highlands, Gunung Perda, 2130 m (K).

Fronds small; upper and lower surfaces both covered with acicular hairs between veins.

Note. The type and another collection have pinnae 2.5 × 0.6 cm; small size and hairiness may be due to exposed position.

**7. *Coryphopteris klossii*** (RIDL.) HOLTUM, *Blumea* 23 (1976) 31. — *Lastrea klossii* RIDL. Trans. Linn. Soc. Bot. 9 (1916) 257; COPEL. Philip. J. Sci. 78 (1951) 428. — *Dryopteris klossii* (RIDL.) v.A.v.R. Handb. Suppl. (1917) 501. — *Thelypteris klossii* (RIDL.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 252. — Type: C. B. KLOSS, W. New Guinea, Wollaston Exped. to Mt Carstensz, Camp VIC, 1800 m (BM; K). — Fig. 4f.

Stipe 20–30 cm long, dark, glandular but not hairy except in the groove; scales 3–4 × 1–1.5 mm. *Lamina* to 30 cm or more long; pinnae c. 20 pairs separated by half their width; basal pinnae a little reduced or not, narrowed in basal third, basal acroscopic lobe a little enlarged and strongly crenate; texture rather rigid when dry. *Largest pinnae* of type 3.3 × 1.0 cm, of another specimen 6 × 1.3 cm; lobes slightly falcate, edges sinuate to toothed at ends of distal veins; costules 2.5–3.5 mm apart; veins 5–7 pairs, thick and slightly prominent; lower surface of rachis and costae bearing rather sparse acicular hairs, many ovate scales to 1 mm long on costae, smaller scales on costules, glands generally; upper surface of rachis and costae bearing short acicular hairs, glands and capitate hairs on surface between veins. *Sori* medial; indusia large, thin, bearing capitate hairs and glands, usually all symmetric.

Distr. *Malesia*: Throughout New Guinea at 1800–3200 m.

8. *Coryphopteris iwatsukii* HOLTUM, Blumea 23 (1976) 31. — Type: K. IWATSUKI *et al.* S. 1012, Sumatra, Atjeh (K).

*Caudex* slender; *stipe* to 20 cm long, very dark at base, minutely hairy; scales rigid, 3 mm long, 0.8 mm wide at base, dorsally with small spherical outgrowths. *Lamina* 25 cm long, texture thin; pinnae 15 pairs; lowest pinnae narrowed at base, basal acroscopic lobe free, dentate, not elongate. *Suprabasal pinnae* to 6.0 × 1.4 cm, acuminate; lobes at right angles to costa, almost all dentate, separated by sinuses 1.5 mm wide; costules 3.5 mm apart; veins 5–6 pairs; lower surface of rachis with hairs 0.5 mm long, of costae with sparse hairs and many glands, larger scales on costae dilated at base, lamina between veins bearing glands and minute erect hairs; upper surface of rachis and costae bearing unicellular acicular hairs, few on costules and veins, surface between veins with many glands. *Sori* medial; indusia thin, bearing very short acicular hairs.

Distr. *Malesia*: N. Sumatra (Gajolands: Mt Kemiri), only known from the type.

Ecol. Mossy forest, 1800–2500 m.

9. *Coryphopteris atjehensis* HOLTUM, Blumea 23 (1976) 32. — Type: K. IWATSUKI *et al.* S. 834, Sumatra, Atjeh, G. Kemiri, 900–1600 m, in evergreen forest (K).

Differs from *C. iwatsukii* as follows: scales on stipe 7 × 1.5 mm, smooth dorsally; pinnae to 9.5 × 1.9 cm, pinna-lobes mostly entire; costules 4–4.5 mm apart; indusia glabrous or with minute capitate hairs.

Distr. *Malesia*: N. Sumatra (Gajolands, Mt Kemiri), known only from the type and DE WILDE 13051.

10. *Coryphopteris obtusata* (v.A.v.R.) HOLTUM, Blumea 23 (1976) 30. — *Dryopteris obtusata* v.A.v.R. Bull. Jard. Bot. Botz II, 28 (1918) 22. — *Thelypteris obtusata* (v.A.v.R.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 253. — Type: C. J. BROOKS 339 S, Sumatra, Benkoelen, Lebong Simpang (BO; BM).

*Dryopteris supravillosa* C. CHR. Gard. Bull. Str. Settl. 7 (1934) 241. — Type: HOLTUM 25471, Mt Kinabalu, 1800 m (BM; K, SING).

*Stipe* 15–25 cm long, dark at base, short-hairy, upper part and rachis dull reddish, scales to 5 × 1.5 mm. *Lamina* 20–35 cm long, pinnae 15–18 pairs; basal pinnae somewhat reduced on smaller fronds, narrowed at base, basal acroscopic lobe dentate, not free. *Largest pinnae* to 7.5 × 1.5 cm, short-acuminate; basal lobes dentate, others sometimes with slight teeth at ends of distal veins; costules 3–4 mm apart; veins 5–8 pairs; lower surface of rachis densely hairy, of costae less so, glands present on all parts of lower surface, those between veins sometimes small (type) or replaced by capitate hairs; scales on lower surface of cos-

tae widened at base; upper surface densely covered with short acicular hairs, some capitate hairs or glands also present. *Sori* medial to inframedial, distal ones sometimes asymmetric where small; indusia bearing glands and capitate hairs.

Distr. *Malesia*: Sumatra, Borneo, New Guinea.

Note. There is variability in Sumatran specimens in abundance of glands or capitate hairs on lower surface of pinnae; a specimen from W. New Guinea is very like the type. Specimens from eastern New Guinea have rather few glands and capitate hairs. The type of *D. supravillosa* is small (lamina 20 cm long) and has capitate hairs between veins on lower surface.

11. *Coryphopteris diaphana* (BRAUSE) HOLTUM, Blumea 23 (1976) 32. — *Dryopteris diaphana* BRAUSE, Bot. Jahrb. 56 (1920) 80. — *Thelypteris diaphana* (BRAUSE) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 251. — Type: LEDERMANN 8903, N.E. New Guinea, Sepik Distr. (B; BM).

*Stipe* 10–15 cm long, dark, glossy, sparsely hairy; scales 2–3 × 0.8 mm, dark, rigid. *Lamina* to 25 cm long; pinnae 15–18 pairs; basal pinnae not or little reduced, a little narrowed at base, basal acroscopic lobe almost free, dentate, not elongate. *Suprabasal pinnae* to 4.5 × 1.2 cm, short-acuminate; lobes oblique, basal ones strongly dentate, rest ± toothed at ends of veins; costules 2.5–3 mm apart; veins 5–6 pairs; lower surface of rachis and costae with short spreading acicular hairs, glands on costae, costules and veins, a few dark narrow scales on costae; upper surface of costules and veins with scattered hairs, no glands nor hairs between veins. *Sori* supramedial; indusia glabrous.

Distr. *Malesia*: New Guinea. Known only from type collection and BRASS 13294 from Idenburg River.

Ecol. Type from 850 m, in moss cushions; BRASS 13294 from 900 m, in *Agathis* forest.

12. *Coryphopteris habbemensis* (COPEL.) HOLTUM, Blumea 23 (1976) 32. — *Dryopteris habbemensis* COPEL. Un. Cal. Publ. Bot. 18 (1942) 216. — *Ctenitis habbemensis* (COPEL.) COPEL. Gen. Fil. (1947) 124; Philip. J. Sci. 78 (1951) 411, pl. 15. — Type: BRASS 9304, N.W. New Guinea, Lake Habbema 3225 m (MICH; BM). — Fig. 4e.

*Stipe* 25–30 cm long, base dark with short brown hairs, reddish distally; scales thin, 5 × 1.5 mm. *Lamina* to 30 cm long; pinnae 18 pairs; basal pinnae not much narrowed at base. *Largest pinnae* 7 × 2 cm, pinnate in basal half; 2–3 pairs pinnules quite free, rest ± adnate to costa, lobes of distal half of pinna connected by a very narrow wing; pinnules 7–12 mm long, 2–3 mm wide, larger ones deeply lobed near base and crenate distally; costules 3.5–4 mm apart; veins 5–8 pairs, forked in basal lobes of larger pinnules; lower surface of

rachis and costae copiously short-hairy, also on costae thin clathrate scales, the larger ones ovate; some sessile glands and smaller scales on costules; acicular hairs on upper surface of costae and costules, no glands. *Sori* medial; indusia thin, glabrous.

Distr. *Malesia*: Middle to east of New Guinea at 1800–3200 m.

Note. See note on 26. *C. stereophylla*.

**13. *Coryphopteris arthrotricha* HOLTUM**, *Blumea* 23 (1976) 33. — Type: HOLTUM 23345, Pahang, Cameron Highlands (K).

*C. viscosa sensu* HOLTUM, Rev. Fl. Malaya 2 (1955) 252, p.p.

*Stipe* to 30 cm long, dark at base, paler distally, hairy only in groove, basal scales 3 mm long, thin. *Lamina* 25–45 cm long; pinnae 20 pairs, well spaced, lowest much narrowed at base with basal acroscopic lobe almost free but not elongate. *Suprabasal pinnae* commonly  $8 \times 1.6$  cm, shortly caudate-acuminate; lobes entire to dentate; costules 3.5–4 mm apart; veins 6–10 pairs; lower surface of rachis and costae bearing minute acicular and capitate hairs, on costae also glands and linear scales, few glands between veins; upper surface of rachis and costae bearing hairs hardly 0.5 mm long which have 1–3 septa, surface between veins glabrous or with a few short acicular and capitate hairs. *Sori* medial; indusia small, bearing short capitate hairs and sometimes glands.

Distr. *Malesia*: Malaya, Sumatra, in ridge forest at 1220–1520 m. This is the common species on the Main Range in Malaya.

**14. *Coryphopteris tahananensis* HOLTUM**, *Blumea* 23 (1976) 33. — Type: HOLTUM 20694, Pahang, Gunung Tahan (K; SING).

Differs from *C. arthrotricha*: scales at base of stipe  $7-8 \times 1$  mm, rigid, acuminate; lobes of pinnae, except basal ones, almost entire; rachis and costae of apical part of frond sometimes bearing multicellular hairs 1.5 mm long on lower surface, on upper surface septate hairs always 1 mm long; glands on costae in some cases rare.

Distr. *Malesia*: Malaya. Three collections from 1800 m on G. Tahan and two from Main Range.

Note. This is intermediate between *C. arthrotricha* and *C. multisora*. One specimen from G. Tahan has the lower surface of rachis and costae densely covered with hairs almost 2 mm long, and a few on costules and veins.

**15. *Coryphopteris athyrioides* HOLTUM**, *Blumea* 23 (1976) 33. — Type: BRASS 24722, Papua, Goodenough Island, on mossy rock (BM; L, LAE).

*Stipe* to 20 cm long, black at base, reddish upwards, short-hairy throughout, basal scales thin, ovate,  $3-4 \times 1.5$  mm. *Lamina* 30 cm long; pinnae 18–20 pairs; lowest pinnae sometimes a little

reduced, basal acroscopic lobe not free. *Largest pinnae*  $6.7 \times 1.7$  cm, short-acuminate; lobes falcate and slightly toothed; costules to 4 mm apart; veins 7–8 pairs, prominent on lower surface; rachis and costae on lower surface densely covered with erect acicular hairs and filiform scales, on rest of surface red glands; no glands on upper surface. *Sori* asplenoid, occupying almost whole length of all veins, some of them hooked as in *Athyrium*, rarely reniform; indusia bearing glands and sometimes a few short acicular hairs.

Distr. *Malesia*: Papua New Guinea (Goodenough I.), only known from the type.

**16. *Coryphopteris pectiniformis* (C. CHR.) HOLTUM**, *Webbia* 30 (1976) 20; *Blumea* 23 (1976) 34. — *Dryopteris pectiniformis* C. CHR. Gard. Bull. Str. Settl. 4 (1929) 379. — *Thelypteris pectiniformis* (C. CHR.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 253; HOLTUM, Rev. Fl. Mal. 2 (1955) 253, f. 144, 624, pl. 1 f. 8. — *Parathelypteris pectiniformis* (C. CHR.) CHING, Acta Phytotax. Sinica 8 (1963) 304. — Type: G. F. HOSE 293, Perak (P; K).

*Thelypteris subglanduligera* CHING, Bull. Fan Mem. Inst. Biol. Bot. 6 (1936) 323. — Type: WRAY 367, Perak, Gunung Batu Puteh (US; CAL, L).

**a. var. *pectiniformis***

*Stipe* dark at base with thin setiferous scales to  $7 \times 1$  mm, distally stramineous, throughout covered with short unicellular hairs. *Lamina* 40–45 cm long, texture thin; pinnae 15–20 pairs, well-spaced; basal pinnae narrowed near base, basal acroscopic lobe not enlarged, sometimes a little dentate. *Suprabasal pinnae* to  $10 \times 1.6$  cm, acuminate; lobes entire, slightly falcate; costules to 3 mm apart; veins 7–8 pairs, very oblique; lower surface of rachis, costae and costules bearing short pale acicular hairs, glands and short erect acicular and capitate hairs on surface between veins; upper surface of costae bearing copious pale acicular hairs more than 0.5 mm long, few hairs on costules and veins, no other hairs. *Sori* medial; indusia with abundant capitate hairs, sometimes a few acicular hairs.

Distr. *Malesia*: Malaya (Taiping Hills, a few records from Main Range, G. Padang in Trengganu).

**b. var. *hirsuta* HOLTUM**, *Blumea* 23 (1976) 34. — Type: HOLTUM 21547, Pahang, Pine-tree hill, near Fraser's Hill (K; SING).

Differs from typical variety: smaller (pinnae to 6.5 cm long); lower surface of costules and veins bearing acicular hairs 1.5 mm long which are septate; indusia bearing acicular hairs 0.5 mm long.

Distr. *Malesia*: Malaya (only known from Pine-tree hill and the ridge connecting it to Fraser's Hill).

c. *var. minor* HOLTUM, *var. nov.*

A *typo speciei differt: pinnis minoribus (usque 4.2 × 0.8 cm); venis 3-jugatis; rhachidi et costis subtus pilis 0.1 mm longis vestitis; paleis stipitis 3 mm longis, 0.8 mm latis*. Type: J. WINKLER s.n. 1912, Sumatra, Pea Radja, in Rosenst. Fil. sumatr. exsicc. n. 143 (P).

Distr. *Malesia*: Sumatra.

Note. This was distributed as *Dryopteris subviscosa* ROSENST., a name not published (not *D. subviscosa* v.A.v.R.). Another specimen (n. 154a) from the same locality, distributed as *D. japonica* *var. stricta*, has somewhat larger pinnae (MICH). The short pinna-lobes have broad tips, so that the pinnae are much like those of *C. hirsutipes* in aspect, but in other characters they agree with *C. pectiniformis*.

**17. *Coryphopteris andersonii* HOLTUM**, *Blumea* 23 (1976) 38. — Type: J. A. R. ANDERSON 4535, Sarawak, Baram Distr., G. Mulu 2000 m (L; K).

*Caudex* to 30 cm tall; *stipes* 20 cm long, dark castaneous at base, paler distally, short-hairy, basal scales 4–5 × 1.5 mm; *rachis* stramineous. *Lamina* to 25 cm long, subcoriaceous, rigid when dry; pinnae 15 pairs, lowest not reduced but slightly narrowed at base with basal acroscopic lobe sometimes dentate, not free. *Suprabasal pinnae* to 5 × 1.2 cm, short-acuminate; lobes oblique, hardly falcate, with rounded tips, basal ones at most slightly dentate; costules 2 mm or little more apart; veins 6 pairs, very oblique, pale and prominent on both surfaces; lower surface of *rachis* covered with hairs 0.3 mm long; hairs on costae few or none, scales on costae narrowly linear or with dilated bases, glands present on and between veins; hairs on upper surface of costae 0.5 mm long, no other hairs nor glands on upper surface. *Sori* medial, symmetric; indusia thin, glabrous.

Distr. *Malesia*: Borneo (Sarawak: Mt Mulu), only known from type.

**18. *Coryphopteris andreae* HOLTUM**, *Blumea* 23 (1976) 35. — Type: MILLAR & HOLTUM NGF 15768, N.E. New Guinea, Morobe Distr., Wau Subdistr., Otibanda Creek 2150 m (LAE; K).

*Stipe* 5–6 cm long, black at base, paler upwards, short-hairy throughout, basal scales thin, 2 × 1 mm, not setiferous. *Lamina* 14 cm long; pinnae 12–15 pairs, lower 2–3 pairs deflexed and narrowed at base, their basal acroscopic lobes slightly enlarged and dentate, almost free. *Largest pinnae* 3.0 × 0.9 cm, apex abruptly acute, lobed almost to costa; lobes entire or slightly dentate; costules 2 mm apart; veins 4 pairs; lower surface of *rachis* and costae densely covered with short erect hairs, very narrow scales and sometimes small ovate ones also present; glands present on all lower surfaces; upper surface with hairs on costa, the rest glabrous or sometimes with a few hairs be-

tween veins. *Sori* medial; indusia large, thin, sometimes bearing short capitate hairs.

Distr. *Malesia*: Papua New Guinea (neighbourhood of Mt Kaindi, several collections; Ekuti Range 2200 m).

**19. *Coryphopteris squamipes* (COPEL.) HOLTUM**, *Blumea* 23 (1976) 35. — *Dryopteris squamipes* COPEL. Philip. J. Sci. 56 (1935) 99, pl. 5. — *Lastrea squamipes* (COPEL.) COPEL. Fern Fl. Philip. (1960) 325. — *Thelypteris squamipes* (COPEL.) REED, *Phytologia* 17 (1968) 315. — Type: RAMOS & EDANO BS 38525, Mindanao, Bukidnon Prov., Mt Lipa, 2000 m (MICH; BO, US).

*Stipe* 5–15 cm long, dark at base, paler distally; scales thin, to 5 mm long, to 2.5 mm wide at base. *Lamina* to 28 cm long; pinnae more than 20 pairs, 6–8 lower pairs gradually smaller, lowest 1.5–2 cm long. *Largest pinnae* commonly 3.5 × 0.9 cm, short-acuminate; lobes oblong, mostly crenate, basal ones dentate; costules 2–2.5 mm apart; veins to 5 pairs; lower surface of *rachis* and costae bearing stiff unicellular hairs to 1 mm long, on costae many small scales sometimes widened at their bases, glands present on costules, veins and surface between veins; upper surface sometimes with a few glands on and near veins. *Sori* medial, distal ones mostly symmetric; indusia glabrous or with a few glands.

Distr. *Malesia*: Philippines (Mindanao, several coll.) and Papua New Guinea (New Ireland, J. R. CROFT 288, pinnae to 6 by 1.4 cm).

**20. *Coryphopteris borealis* HOLTUM**, *Blumea* 23 (1976) 35. — Type: M. JACOBS 7588, Northern Luzon, Mt Tayaboc, 2300 m, on ridge in shade (K; L).

*Caudex* to 30 cm tall. *Stipe* 20–25 cm long, very dark at base, dark reddish distally; scales to 4 × 2.5 mm. *Lamina* to 45 cm long; pinnae 20 pairs or more; lower pinnae 2–4 pairs somewhat reduced, lowest 2.5–3 cm long. *Largest pinnae* 4.5 × 1.2 cm (fertile), 5.0 × 1.3 cm (sterile), abruptly narrowed at apex; lobes slightly oblique, subtruncate, toothed at ends of veins, lowest lobes of fertile pinnae strongly dentate; costules 3–3.5 mm apart; veins 4 pairs; lower surface of *rachis* and costae bearing hairs almost 1 mm long, scales on costae all very narrow, costules and veins bearing small glands; upper surface of pinnae glabrous apart from hairs on costae. *Sori* inframedial; indusia large, glabrous.

Distr. *Malesia*: Philippines (Luzon), type specimen only.

**21. *Coryphopteris meibasis* HOLTUM**, *Blumea* 23 (1976) 36. — Type: T. G. WALKER 8730, N.E. New Guinea, Morobe Distr., trail from Sewe to Freyburg Pass, 2300–2450 m (BM).

*Stipe* to 25 cm long, covered with pale slender



hairs, basal scales little more than 1 mm wide. *Lamina* to 40 cm long; pinnae 20 pairs, lower 3 pairs gradually smaller, lowest 3.5–4.5 × 1.1–1.3 cm, their basal acroscopic lobes not enlarged. *Largest pinnae* 9 × 1.9 cm (sterile), 8.5 × 1.7 cm (fertile), acuminate; lobes oblique, strongly dentate; costules 4.5–5.5 mm apart; veins to 7 pairs; lower surface of rachis with many hairs 1 mm long, similar but shorter hairs and very narrow scales on costae, glands on costules and veins, few glands between veins; upper surface glabrous apart from hairs on costae and a few on costules and veins, no glands. *Sori* inframedial, round; indusia thin, pale, with a few hairs.

Distr. *Malesia*: Papua New Guinea; known from type only.

**22. *Coryphopteris pubirachis* (BAK.) HOLTUM**, *Blumea* 23 (1976) 37. — *Nephrodium pubirachis* BAK. *J. Bot.* 14 (1876) 344. — *Dryopteris pubirachis* (BAK.) C. CHR. *Ind. Fil.* (1905) 287; Bishop Mus. Bull. 177 (1943) 82. — *Thelypteris pubirachis* REED, *Phytologia* 17 (1968) 307. — Type: WHITMEE 202, Samoa (K).

*Dryopteris mataanae* BRAUSE, *Notizbl. Bot. Gart. Berlin* 8 (1922) 1939. — Type: VAUPEL 460, Samoa (B; BM).

**a. var. *pubirachis***

*Stipe* 15–20 cm long, very dark throughout; scales to 5 × 1.5 mm, thin, lacking acicular hairs; *rachis* dark to light reddish. *Lamina* to 25 cm long; pinnae 12–15 pairs, well spaced; basal pinnae wider than next pair, narrowed to base on basis-copic side, basal acroscopic lobe free, strongly dentate, not elongate. *Suprabasal pinnae* to 7.5 × 1.8 cm, short-acuminate, lobes slightly oblique, almost all dentate at ends of veins, basal acroscopic lobe usually longer than rest; costules 4 mm apart; veins 6–7 pairs; lower surface of rachis and costae with slender acicular hairs less than 0.5 mm long, glands present on costae, costules and veins, none or few between veins, a few narrow scales widened at base present on costae; hairs on upper surface of rachis and costae longer and thicker than on lower surface, a few on costules and veins, not elsewhere. *Sori* inframedial, basal ones a little divergent; distal sori smallest, sometimes a little asymmetric; indusia bearing glands, a few hairs sometimes also present.

Distr. *Polynesia*: Samoa, Tahiti.

**b. var. *major* HOLTUM**, *Blumea* 23 (1976) 37. — Type: BRAITHWAITE 4378, Solomon Islands, New Georgia Group, Kolombangara, 1650 m (K).

Differs from typical form: larger, with *lamina* to 40 cm long; pinnae to 20 pairs; largest suprabasal pinnae to 10 × 1.8 cm; hairs on lower surface of rachis and costae sometimes few.

Distr. *Solomon Islands*, Bougainville, in *Malesia*: New Ireland, New Guinea.

**c. var. *philippinensis* HOLTUM**, *Blumea* 23 (1976) 37. — Type: RAMOS & EDANO BS 37959, Luzon, Mt Masapilid, Bontoc Subprov. (K).

Differs from type: larger, with basal pinnae to 9 × 2 cm; lower surface of pinnae between veins glandular, of upper surface bearing some acicular hairs; lobes of pinnae, apart from basal ones, almost entire.

Distr. *Malesia*: throughout Philippines, on mountains.

Note. Young plants appear to have lower pinnae somewhat smaller than next and have some resemblance to *C. squamipes*, but well-grown plants of the two, as collected in Mindanao, are distinct.

**d. var. *sulawesica* HOLTUM**, *Blumea* 23 (1976) 38. — Type: T. G. WALKER 12354, Celebes, on ridge above river Pasir, 2000–2200 m (BM).

Differs from type: largest pinnae 1.2 cm wide; lower surface between veins bearing glands; upper surface between veins bearing acicular and capitate hairs.

Distr. *Malesia*: Celebes and Borneo (Sarawak: Mt Mulu), 1800–2200 m; two collections known.

**23. *Coryphopteris athyriocarpa* (COPEL.) HOLTUM**, *Blumea* 23 (1976) 38. — *Dryopteris athyriocarpa* COPEL. *Philip. J. Sci.* 3 (1908) Bot. 344. — Type: BROOKS & HEWITT 2, Bongo Range, Sarawak (MICH).

*Stipe* to 21 cm long, base very dark, becoming reddish distally, rachis paler; basal scales to 5 mm long, base dilated with isodiametric cells, above base less than 1 mm wide with elongate cells. *Lamina* 20 cm long; free pinnae 18 pairs; basal pinnae largest, 5.5 × 1.8 cm, their lobes lobulate, 3–4 pairs basal lobes gradually shorter. *Suprabasal pinnae* to 4 × 1.2 cm, short-acuminate; basal pair of lobes lobulate, rest crenate; costules 3 mm apart; veins 4–5 pairs, very oblique; lower surface of rachis bearing short capitate hairs, of costae capitate hairs, glands and very narrow scales, acicular hairs lacking; upper surface of rachis bearing acicular hairs 0.5 mm long, shorter ones on costae and scattered on costules and veins, between veins many capitate hairs and a few short acicular hairs, no glands. *Sori* medial, distal ones athyrioid; indusia with a few glands, not hairs.

Distr. *Malesia*: Borneo (Sarawak: W. Kalimantan, Pontianak R., HANS WINKLER 534, in BM); only two collections known.

Note. This has the narrow scales of *C. viscosa* but smaller fronds and a different distribution of glands and hairs.

**24. *Coryphopteris tanggamensis* HOLTUM**, *Blumea* 23 (1976) 38. — Type: M. JACOBS 8255, S. Sumatra, G. Tanggamus, 2000 m (L; K).

*Caudex* to 30 cm tall. *Stipe* 30 cm long,

glabrous, dark purplish at base, distally dull reddish. basal scales  $5 \times 1.2$  mm. *Lamina* to 35 cm long; pinnae 22 pairs, widely spaced; two pairs lower pinnae deflexed but not reduced; lowest pair somewhat narrowed at base, basal acroscopic lobe elongate, dentate, not free. *Suprabasal pinnae* to  $7 \times 1.5$  cm, acuminate; lobes oblique, falcate, margins at base dentate, apex rounded and entire; costules 3.5 mm apart; veins 6–7 pairs; lower surface of rachis bearing many capitate and fewer acicular hairs, of costae bearing capitate hairs or small glands and linear scales, no glands seen between veins; upper surface of rachis bearing hairs 0.7 mm long, those on costae shorter, costules and veins with sparse hairs, none between veins. *Sori* inframedial, distal ones mostly symmetric; indusia bearing capitate hairs.

Distr. *Malesia*: S. Sumatra (Mt Tanggamus), known from type only.

**25. *Coryphopteris engleriana*** (BRAUSE) HOLTUM, *Blumea* 23 (1976) 40. — *Dryopteris engleriana* BRAUSE, *Bot. Jahrb.* 49 (1912) 19. — *Phegopteris engleriana* (BRAUSE) v.A.v.R. *Handb. Suppl.* (1917) 309. — *Thelypteris engleriana* (BRAUSE) REED, *Phytologia* 17 (1968) 274. — Type: L. SCHULTZE 330, N.E. New Guinea, Sepik Distr. (B).

*Stipe* and rachis dark; base of stipe not seen. *Lamina* to 50 cm long; pinnae 18 pairs, widely spaced; basal pinnae not reduced, narrowed gradually in basal half, basal pair of lobes free, not enlarged, not dentate. *Suprabasal pinnae* to  $10.8 \times 1.6$  cm with stalks 1 mm long, apex narrowly acuminate; middle lobes somewhat falcate with rounded ends, separated by rather wide sinuses, edges slightly crenate; costules 4.5 mm apart; veins 7 pairs; lower surface lacking acicular hairs, costae bearing narrow scales (often uniseriate), no glands; upper surface with coarse brown hairs on rachis and costae, no others. *Sori* inframedial except basal ones, exindusiate; spores with many small wings.

Distr. *Malesia*: Papua New Guinea. Known only from type and one other collection from same locality.

**26. *Coryphopteris stereophylla*** (v.A.v.R.) HOLTUM, *Blumea* 23 (1976) 40. — *Dryopteris stereophylla* v.A.v.R. *Nova Guinea* 14 (1924) 17. — *Thelypteris stereophylla* (v.A.v.R.) CHING, *Bull. Fan Mem. Inst. Biol. Bot.* 10 (1941) 254. — Type: H. J. LAM 1785, W. New Guinea, Doormantop, 3200 m (L).

*Stipe* to 30 cm, base dark, rest flushed with red; hairs very short, thick, brownish; scales  $3 \times 1$  mm, dark. *Lamina* to 25 cm long with 15–20 pairs well-spaced pinnae, texture thick, rigid when dry; lowest pinnae not reduced, narrowed a little at basiscopic base. *Suprabasal pinnae* to  $7.5 \times 1.5$  cm, with 4–8 pairs of free or separately adnate

pinnules in basal part, apical part lobed almost to costa; pinnules and lobes 1–2 mm wide, almost all crenate, separated by wide sinuses; costules 3 mm apart on type, to 4 mm on another specimen; veins 4–5 pairs, grooved on upper surface; lower surface of rachis covered with brown hairs 0.3 mm long and thin scales, costae with similar hairs and ovate-acute to lanceolate clathrate scales 1 mm long, no glands; upper surface bearing very short erect hairs on edges of grooved costa. *Sori* medial; indusia small, thin, glabrous.

Distr. *Malesia*: Papua New Guinea. Only known from the type and PULLE 883 from Mt Helliwig, 2000 m (L).

Note. This species is close to *C. habbemensis*, differing from the latter in more coriaceous texture, narrower pinnules and lack of glands on lower surface.

**27. *Coryphopteris horizontalis*** (ROSENST.) HOLTUM, *Blumea* 23 (1976) 40. — *Athyrium horizontale* ROSENST. *Nova Guinea* 8 (1912) 722. — *Dryopteris horizontalis* (ROSENST.) v.A.v.R. *Bull. Jard. Bot. Btztg* II, 11 (1913) 10; *Handb. Suppl.* (1917) 151. — Type: VON ROEMER 1136, W. New Guinea, Helliwig Mts, 1350–1600 m (S-PA; BO).

*Stipe* 15 cm long, dark, densely covered with hairs 1 mm long and thin scales  $3 \times 1.5$  mm. *Lamina* to 40 cm long; pinnae 18–20 pairs; lowest pinnae a little reduced and narrowed to base. *Suprabasal pinnae* to  $7 \times 1.5$  cm, sessile, short-acuminate; lobes oblong, serrate-crenate, basal lobes most strongly so; costules to 4 mm apart; veins 6–7 pairs; rachis beneath bearing acicular hairs 1 mm long, shorter hairs on costae, sparse on costules, no glands; linear scales, sometimes dilated at base, on costules; hairs on upper surface of rachis as lower, on costae shorter, copious short hairs on surface between veins. *Sori* inframedial, mostly not athyrioid; indusia thin, short-hairy.

Distr. *Malesia*: Papua New Guinea. Known only from type and PULLE 633, Mt Dromedaris 1250 m (L).

**28. *Coryphopteris microlepigera*** HOLTUM, *Blumea* 23 (1976) 41. — Type: PULLE 1078, W. New Guinea, Mt Treub, 2300 m (L; BM).

*Stipe* to 15 cm long, very dark; hairs in groove 0.5 mm long, basal scales 2–3 mm long, thin; rachis dark reddish. *Lamina* to 28 cm long; pinnae 20 pairs; lower pinnae 1–3 pairs somewhat reduced. *Largest pinnae*  $5.5 \times 1.1$  cm, short-acuminate; basal lobes conspicuously dentate, rest with  $\pm$  sinuous margins; costules 3 mm apart; veins 4–5 pairs; lower surface of rachis covered with brown hairs 0.5–0.8 mm long, acicular hairs on costae shorter, costules and veins bearing very short capitate hairs, scales on costae lanceolate, at base 5–10 cells wide; upper surface of rachis with hairs

as lower surface, hairs on costae shorter, surface between veins covered with short acicular hairs. *Sori* a little supramedial, sometimes slightly athyroid; indusia glabrous.

Distr. *Malesia*: Western New Guinea and Moluccas (Amboina).

Note. A second New Guinea collection, from Mt Nettiti at 1800 m (VAN ROYEN & SLEUMER 8226) differs in shorter narrower pinnae with few hairs between veins on upper surface; a specimen collected by TEYSMANN on Mt Toena, Amboina (BO) is similar.

**29. *Coryphopteris propria* (v.A.v.R.) HOLTUM**, *Blumea* 23 (1976) 41. — *Dryopteris propria* v.A.v.R. Bull. Jard. Bot. Botz 16 (1914) 10; Handb. Suppl. (1917) 152. — Type: RACHMAT 496, Central Celebes, Tondo-Tondo (BO; L).

*Stipe* to 13 cm long, dark; scales  $3 \times 1$  mm, thin. *Lamina* to 14 cm long; pinnae 10 pairs; basal pinnae largest, to  $4 \times 1.3$  cm, a little narrowed at base, basal acroscopic lobe enlarged, dentate, free. *Suprabasal pinnae* to  $3.5 \times 1.1$  cm, short acuminate, lobes entire or with slight teeth at ends of distal veins; costules to 3 mm apart; veins 4 pairs; abundant very short capitate hairs on lower surface of rachis, costae, costules, veins and surface between veins; sparse short acicular and many short capitate hairs on upper surface of costae, very short acicular hairs on costules and veins, short capitate hairs between veins. *Sori* medial, basal ones often somewhat athyroid; indusia bearing many capitate hairs and sometimes a few acicular ones.

Distr. *Malesia*: Central Celebes; known from type collection only.

**30. *Coryphopteris lauterbachii* (BRAUSE) HOLTUM**, *Blumea* 23 (1976) 41. — *Dryopteris lauterbachii* BRAUSE, Bot. Jahrb. 49 (1912) 18; v.A.v.R. Handb. Suppl. (1917) 150. — *Thelypteris lauterbachii* (BRAUSE) REED, *Phytologia* 17 (1968) 287. — Type: L. SCHULTZE 273, N.E. New Guinea, Sepik Distr. (B).

*Stipe* to 25 cm, dark, upper part and rachis dull reddish; soft pale hairs on abaxial surface; scales  $3-4 \times 1$  mm, thin. *Lamina* to 43 cm long; pinnae to 24 pairs; basal pinnae a little reduced, slightly narrowed at base, basal lobe not free. *Suprabasal pinnae*  $7.5 \times 1.7$  cm, sessile, base truncate and a little dilated both sides, apex acuminate; lobes slightly oblique, slightly crenate; costules  $3.5$  mm apart; veins to 8 pairs; rachis and costae beneath bearing short acicular hairs, few on costules, very small capitate hairs on surface between veins, many small scales on costae and costules; hairs on upper surface of costae longer, some consisting of 2 cells, sparse hairs on costules and veins. *Sori* medial; indusia large, thin, short-hairy.

Distr. *Malesia*: Papua New Guinea, known from type only.

**31. *Coryphopteris fasciculata* (FOURN.) HOLTUM**, *Blumea* 23 (1976) 42. — *Aspidium fasciculatum* FOURN. Ann. Sci. Nat. V, 18 (1873) 295. — *Nephrodium fasciculatum* (FOURN.) BAK. Ann. Bot. 5 (1891) 320. — *Thelypteris fasciculata* (FOURN.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 251; BROWNLIE in Aubrév. Fl. Nouv. Cal. 3 (1969) 210, pl. xxvii. — Type: BALANSA 3568, New Caledonia, Mt Humboldt (P).

*Nephrodium macgregorii* BAK. Ann. Bot. 5 (1891) 320, new name for *N. simulans* BAK. J. Bot. 28 (1890) 106, non BAK. 1874 nec BAK. 1888. — *Dryopteris conterminoides* C. CHR. Ind. Fil. 258, nom. nov. superfl. — *Lastrea macgregorii* (BAK.) RIDL. Trans. Linn. Soc. Bot. 9 (1916) 257. — *Dryopteris macgregorii* (BAK.) C. CHR. Ind. Fil. Suppl. III (1934) 90. — *Lastrea conterminoides* (C. CHR.) COPEL. Philip. J. Sci. 78 (1951) 424. — *Thelypteris conterminoides* (C. CHR.) REED, *Phytologia* 17 (1968) 269. — Type: W. MCGREGOR 18, Papua, Mt Knutsford (K).

*Dryopteris engleriana* var. *hirta* C. CHR. Brittonia 2 (1937) 296. — Type: BRASS 5032, Papua, Mt Tafa, 2400 m (BM; K, NY).

*Stipe* 12–20 cm long, dark at base only, reddish upwards, bearing hairs 1 mm long; scales  $3 \times 1$  mm or somewhat larger. *Lamina* 30–40 cm long; pinnae 25–30 pairs; up to 8 pairs lower pinnae deflexed and gradually reduced, lowest 1–2 cm long. *Largest pinnae*  $4-5.5 \times 0.8-1.3$  cm, short acuminate; lobes  $\pm$  dentate at vein-ends, basal lobes most strongly; costules  $2.5-3$  mm apart; veins 3–4 pairs; lower surface of rachis and costae bearing rather thick acicular hairs 1 mm long, linear scales present on costae and costules, rarely a few glands on costae only, short erect hairs sometimes present between veins; copious acicular hairs on upper surface of rachis and costae, few on costules and veins, sometimes short capitate hairs present between veins. *Sori* inframedial; indusia thin with short capitate hairs and few to many short acicular hairs.

Distr. New Caledonia, East *Malesia*: New Guinea, Celebes, at 1800–3000 m.

Note. The type of *N. macgregorii* BAK. is a poor specimen with basal pinnae lacking; it agrees well with other specimens in pubescence. Some specimens from both east and west New Guinea have a few glands on lower surface of costae, others agree with the type in having none. All Celebes specimens have some short hairs between veins on both sides.

**32. *Coryphopteris hubrechtensis* HOLTUM**, *Blumea* 23 (1976) 42. — Type: VERSTEEG 2433, W. New Guinea, Mt Hubrecht 3000 m (BM; L).

*Stipe* to 35 cm long, very dark, glossy, glabrous except near apex which is dull reddish. *Lamina* 20 cm long; pinnae 18 pairs, rigid, several lower ones deflexed, lowest 1–2 pairs slightly reduced. *Largest pinnae* 3 cm long, to 1 cm wide, apex

obtuse; lobes almost entire, basal acroscopic lobe slightly enlarged, almost free and slightly dentate; costules 2.5 mm apart; veins 4–5 pairs, sometimes forked in the basal acroscopic lobe; lower surface of rachis bearing copious acicular hairs 0.5 mm long, of costae bearing narrow scales 0.5–0.8 mm long, minute uniseriate scales also on costules and veins, no glands; upper surface glabrous apart from costae. *Sori* near costules; indusia rather large, glabrous.

Distr. *Malesia*: West New Guinea, c. 3000 m. Besides the type, 2 collections by BRASS from Lake Habbema.

33. *Coryphopteris brevopilosa* HOLTUM, *Blumea* 23 (1976) 43. — Type: PULLE 532, W. New Guinea, Mt Perameles, 900 m, on limestone (L).

*Stipe* 16–24 cm long, very dark at base, paler upwards, covered with hairs 0.3 mm long; scales  $3 \times 1$  mm, thin. *Lamina* to 30 cm long, thin; pinnae 15–18 pairs; lowest pinnae not or little shorter than next, 1.8 cm wide, with acroscopic basal lobe free and strongly dentate. *Suprabasal pinnae* to  $6.5 \times 1.5$  cm, with winged stalk 1 mm long; apex acuminate, lobes almost all dentate and separated by distinct sinuses; costules 3.5 mm apart; veins 6 pairs; rachis and costae beneath covered with hairs 0.2 mm long, costae bearing also subsessile glandular hairs and narrow scales, rest of lower surface glabrous; upper surface of rachis with hairs 0.5 mm long, those on costae 0.2 mm long. *Sori* medial, upper ones always athyroid; indusia thin, glabrous.

Distr. *Malesia*: West New Guinea (Mt Perameles, 900 m), known from type only.

34. *Coryphopteris oligolepia* (v.A.v.R.) HOLTUM, *Blumea* 23 (1976) 43. — *Dryopteris oligolepia* v.A.v.R. *Nova Guinea* 14 (1924) 17. — *Thelypteris oligolepia* (v.A.v.R.) CHING, *Bull. Fan Mem. Inst. Biol. Bot.* 10 (1941) 253. — Type: LAM 1977, W. New Guinea, Doormantop 2520 m (L).

*Stipe* 12–20 cm long, dark glossy, scales  $2-3 \times 1$  mm. *Lamina* to 25 cm long; pinnae 20 pairs; lowest pinnae deflexed and reduced, their basal lobes free and dentate. *Largest pinnae*  $4.0 \times 1.3$  cm, short acuminate, with stalks hardly 1 mm long; lobes oblique, crenulate; costules 3–4 mm apart; veins 3–5 pairs; lower surface of rachis castaneous, glabrous, all other lower surfaces bearing scattered very small capitate hairs, some linear scales on costae; upper surface hairy on edges of groove of rachis and costae, few hairs on costules. *Sori* near costules, sometimes asymmetric; indusia small with some capitate hairs.

Distr. *Malesia*: Western New Guinea, several collections.

Ecol. Twice recorded as an epiphyte; at 1800–2500 m.

35. *Coryphopteris coriacea* (BRAUSE) HOLTUM,

*Blumea* 23 (1976) 43. — *Dryopteris coriacea* BRAUSE, *Bot. Jahrb.* 56 (1920) 63. — *Thelypteris coriacea* (BRAUSE) CHING, *Bull. Fan Mem. Inst. Biol. Bot.* 10 (1941) 251. — *Lastrea coriacea* (BRAUSE) COPEL. *Philip. J. Sci.* 78 (1951) 428. — Type: LEDERMANN 10965, N.E. New Guinea, Sepik Distr., Hunsteinspitze 1300 m (B).

*Dryopteris coriacea* var. *elata* BRAUSE, l.c. — Type: LEDERMANN 11291, same locality.

*Stipe* dark, glossy, 8–12 cm long, hairs on adaxial side short; scales  $8-10 \times 1.5-2$  mm; rachis reddish, green towards apex. *Lamina* to 26 cm long; pinnae 12 pairs; lower 3–5 pairs pinnae deflexed and short-stalked, narrowed at base on both sides. *Largest pinnae*  $5.5 \times 1.5$  cm (of var. *elata*  $8.5 \times 2.0$  cm), short-acuminate; lobes oblique (except basal ones) and slightly falcate, almost or quite entire; costules 3.5 mm apart; veins to 6 pairs, grooved above and flat beneath; lower surface quite glabrous, some small dark scales present on costae; upper surface hairy on rachis and costae, scattered hairs on margins of lobes. *Sori* near margin; indusia thin, glabrous.

Distr. *Malesia*: Papua New Guinea. Known only from the two LEDERMANN collections.

36. *Coryphopteris ledermannii* (HIERON.) HOLTUM, *Blumea* 23 (1976) 44. — *Athyrium ledermannii* HIERON. *Bot. Jahrb.* 56 (1920) 133. — Type: LEDERMANN 11906, N.E. New Guinea, Schraderberg, 2070 m (B).

*Stipe* dark, glossy, hairy in groove only, 15 cm long. *Lamina* to 20 cm long; pinnae well spaced, to 13 pairs, texture thin; basal pinnae short-stalked, somewhat reduced. *Largest pinnae*  $2.5 \times 0.8$  cm, apex obtuse, in the middle lobed about half-way to costa, towards base more deeply, lobes entire or slightly dentate; costules to 3 mm apart; veins 3–4 pairs in basal lobe, 2 pairs in middle lobes; lower surfaces quite glabrous, no scales seen; upper surface with short hairs on rachis and costae only. *Sori* medial, almost all athyroid; indusia glabrous.

Distr. *Malesia*: Papua New Guinea, only known from the type.

Ecol. Epiphyte in moss-forest.

37. *Coryphopteris dura* (COPEL.) HOLTUM, *Blumea* 23 (1976) 44. — *Dryopteris dura* COPEL. *Leaf. Philip. Bot.* 3 (1910) 805; v.A.v.R. *Handb. Suppl.* (1917) 148. — *Lastrea dura* (COPEL.) COPEL. *Gen. Fil.* (1947) 135; *Fern Fl. Philip.* (1960) 323. — *Thelypteris dura* (COPEL.) REED, *Phytologia* 17 (1968) 274. — Type: ELMER 11674, Mindanao, Mt Apo, 2600 m (MICH; BM, E, L).

*Stipe* dark near base, paler distally, 20–30 cm long, glabrous except for groove of upper part; scales  $5 \times 1-2$  mm, acuminate. *Lamina* to 25 cm long; pinnae 18 pairs, rather thick; basal pinnae sessile, sometimes slightly reduced, a little narrowed at base, basal acroscopic lobe free, orbi-

cular, a little dentate. *Largest pinnae*  $4.5 \times 1.1$  cm, apex blunt, lobed at base to 1 mm from costa, less deeply towards apex, lobes rounded, entire except basal acroscopic ones; costules 3–3.5 mm apart; veins 3–4 pairs, slightly prominent on both sides; lower surfaces hairless apart from edges of lobes, scales on costae 2–3 cells or more wide at base; short thick hairs on upper surface of rachis and costae. *Sori* near costules; indusia glabrous, sometimes a little athyroid.

Distr. Malesia: Philippines (Mindanao: Mt Apo), 2600 m.

**38. *Coryphopteris platyptera* (COPEL.) HOLTUM**, *Blumea* 23 (1976) 45. — *Dryopteris platyptera* COPEL. Univ. Cal. Publ. Bot. 18 (1942) 219. — *Lastrea platyptera* (COPEL.) COPEL. Gen. Fil. (1947) 139; Philip. J. Sci. 78 (1951) 433, pl. 17. — *Thelypteris platyptera* (COPEL.) REED, *Phytologia* 17 (1968) 304. — Type: BRASS 11328, N. New Guinea, Bele River (MICH; L).

*Stipe* 20–25 cm, dark and glossy throughout; scales ovate, cordate,  $2 \times 1$  mm, thin. *Lamina* 30 cm long; pinnae to 18 pairs, well spaced, many distinctly stalked; basal pinnae slightly reduced, stalked 1 mm, basal acroscopic lobe quite free, a little dentate. *Largest pinnae* 5.5–7 cm long, 1.3–2 cm wide, caudate-acuminate (cauda 7–15 mm long, entire), deeply lobed throughout, lobes in basal part of pinna  $\pm$  crenate-dentate; costules 3.5–4 mm apart; veins to 6 pairs; lower surface hairless apart from edges of lobes, ovate-acute scales present on costae, very small filamentous scales on costules and veins; stiff dark hairs on upper surface of rachis and costae. *Sori* inframedial; indusia small, glabrous.

Distr. Malesia: New Guinea. Known only from type collection.

Ecol. On rocky banks of stream at 2200 m.

**39. *Coryphopteris subnigra* (BRAUSE) HOLTUM**, *Blumea* 23 (1976) 45. — *Dryopteris subnigra* BRAUSE, Bot. Jahrb. 56 (1920) 82. — *Thelypteris subnigra* (BRAUSE) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 254. — *Lastrea subnigra* (BRAUSE) COPEL. Gen. Fil. (1947) 140; Philip. J. Sci. 78 (1951) 427. — Type: LEDERMANN 11962, N.E. New Guinea, Sepik Distr. (B).

*Stipe* to 24 cm long, very dark, glabrous apart from hairs in groove; scales  $3-4 \times 1$  mm. *Lamina* to 25 cm long; pinnae 12 pairs, well spaced; lower pinnae stalked hardly 1 mm, narrowed to base on basiscopic side, basal acroscopic lobe free (also on all other free pinnae) and dentate. *Largest pinnae*  $5-6 \times 1.4$  cm, short-acuminate, where sterile lobed to 1 mm from costa, where fertile more deeply; lobes  $\pm$  dentate, most strongly where fertile, oblique; costules 3–3.5 mm apart; veins to 6 pairs, prominent and slender on both surfaces; lower surfaces lacking acicular hairs, a few short capitate hairs sometimes on costae,

scales with widened base present on costae, uniseriate scales on costules; short acicular hairs on upper surface of rachis and costae. *Sori* near costules; indusia small, glabrous, sporangia often with a red glandular cell on stalk.

Distr. Malesia: Papua New Guinea. Many collections, 1500–3000 m. Misima I., 1000 m.

Ecol. The type grew as an epiphyte in moss cushions; no others so reported.

**40. *Coryphopteris badia* (v.A.v.R.) HOLTUM**, *Blumea* 23 (1976) 44. — *Dryopteris badia* v.A.v.R. Bull. Jard. Bot. Btzig II, 16 (1914) 9; Handb. Suppl. (1917) 149. — *Thelypteris badia* (v.A.v.R.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 250. — Type: MATTHEW 674, Sumatra, Mt Tandikat (BO; E).

*Dryopteris linearis* COPEL. Philip. J. Sci. 12 (1917) Bot. 56. — Type: CLEMENS 11069, Mt Kinabalu, Marei Parei ridge (MICH; BM, BO, K).

*Dryopteris villosipes* GEPP in Gibbs, Dutch N.W. New Guinea (1917) 70. — Type: L. S. GIBBS 5627, W. New Guinea, Arfak Mts (BM).

*Dryopteris rigidifolia* v.A.v.R. Nova Guinea 14 (1924) 18. — *Thelypteris rigidifolia* (v.A.v.R.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 254. — Lectotype (HOLTUM 1976): LAM 1562, W. New Guinea, Doormantop (BO). — Fig. 4g–h.

*Stipe* varying much in length according to habitat (extremes 10 cm, 70 cm), dark, glossy, with hairs in groove only, at base often bearing a tangled mass of slender hairs which are glossy golden brown when dry; scales narrow, varying with size of frond; rachis also dark throughout. *Lamina* varying from 10 cm long (type of *D. villosipes*) to 65 cm (specimen from Atjeh); pinnae 15 pairs on small plants, to 30 pairs on large ones, texture always thick, rigid when dry; nearly all pinnae distinctly stalked; basal pinnae sometimes a little reduced, little narrowed at base, basal acroscopic lobe free or nearly so. *Largest pinnae* commonly  $5-6 \times 1.2-1.5$  cm (extremes  $1.7 \times 0.5$ ,  $8 \times 2$  cm), lobed to about 1 mm from costa; lobes entire or nearly so, deciduously ciliate on edges; costules less than 2 mm apart on small plants, 3–3.5 mm on large ones; veins commonly 4–5 pairs (extremes 2 and 6 pairs), sometimes grooved on both sides; lower surfaces usually quite glabrous apart from hair-like scales on costae and costules (a few acicular hairs on costae of type of *D. linearis*, Fig. 4h); upper surface of rachis and costae bearing rigid dark brown hairs. *Sori* near costules; indusia glabrous, sporangia sometimes bearing 2–3 slender non-glandular hairs on their stalks.

Distr. Malesia: Sumatra, Malaya, Sarawak, Sabah, Celebes, New Guinea.

Ecol. In mossy forest at 1400–2500 m, usually in moss cushions, several times reported in moss cushions on tree-branches. The largest specimen

seen, from Atjeh, was an epiphyte. The slender hairs at base of stipes resemble root-hairs, and perhaps have the same function, absorbing water from moss-cushions.

**41. *Coryphopteris inopinata* HOLTUM, sp. nov.**

*Caudex gracilis longe-repens; lamina usque 11.5 cm longa; pinnae usque 2.1 × 0.6 cm, lobis dentatis; costae subtus pilis acicularibus destitutaе, eglandulosae, paleis linearibus praeditae; pagina superior pinnarum inter venas glabra; indusia glabra.* — Type: J. R. CROFT, LAE 65849, Telefomin Subdistr. West Sepik Distr., N.E. New Guinea, 2700 m (LAE; K, NSW).

*Caudex* a slender black rhizome 1.5–2.0 mm diameter, bearing fronds 1–3 cm apart; scales c. 4 × 1 mm; *stipe* 12–20 cm long, dark at base, paler distally, slender hairs present on adaxial side only. *Lamina* to 11.5 cm long; pinnae 12 pairs; basal pinnae narrowed towards their bases, basal acroscopic lobe 2 mm long, free or nearly so, basal

basiscopic lobe smaller with decurrent base; fifth pair of pinnae with almost symmetric base and winged stalk 0.5 mm long. *Largest pinnae* 2.3 × 0.7 cm; apex subabruptly narrowed and rounded; edges lobed to 1 mm from costa, lobes obliquely quadrate with teeth at ends of veins; costules 2.5 mm apart; veins 3 on acroscopic side of costule, 2 on basiscopic side; *lower surface* of rachis and pinnae lacking hairs of any kind, glands also absent, scales on costae narrowly linear (2–4 cells wide at base); *upper surface* lacking hairs between veins. *Sori* near base of veins; indusia small, glabrous.

*Distr. Malesia:* Papua New Guinea (Telefomin, 2700 m).

*Note.* Apart from the rhizome, this is near *C. subnigra* but has much smaller pinnae. No other known *Coryphopteris* has this habit. The NSW isotype has fronds closer together on the caudex, which appears to be decumbent; it has a branch near its base.

## 6. PARATHELYPTERIS

(H. ITO) CHING, *Acta Phytotax. Sinica* 8 (1963) 300, p.p. — *Thelypteris* sect. *Parathelypteris* H. ITO in Nakai & Honda, *Nov. Fl. Jap. n. 4* (1939) 127, excl. *T. hirsutipes* et *T. simozawae*. — *Thelypteris* group 2 CHING, *Bull. Fan Mem. Inst. Biol. Bot.* 6 (1936) 246, excl. *T. hirsutipes*. — *Thelypteris* subg. *Thelypteris* sect. *Thelypteris* K. IWATS. *Mem. Coll. Sci. Univ. Kyoto B*, 31 (1965) 157, groups of *T. glanduligera* and *T. japonica* p.p. — *Wagneriopteris* LÖVE & LÖVE, *Taxon* 26 (1977) 325 excl. *W. ogasawarensis*; HOLTUM, *Acta Phytotax. Geobot.* 29 (1978) 16. — **Fig. 5a–b.**

Rather small ferns; caudex slender, creeping, sometimes much elongate; scales bearing superficial unicellular hairs, either spherical, capitate or acicular; basal pinnae in most species not or little reduced, in *P. beddomei* several pairs progressively smaller; pinnae deeply lobed, basal one or more lobes sometimes free; basal acroscopic lobe or leaflet often somewhat enlarged and dentate; veins free, basal ones both reaching margin above base of sinuses between lobes; some acicular hairs on lower surface of costae of *P. beddomei* septate, on upper surface always unicellular; scales on lower surface of costae never large or abundant; sessile glands almost always present on lower surfaces; sori indusiate; sporangia short-stalked, never with glands or setae near annulus, a sessile gland sometimes present on the stalk; spores opaque with a narrow wing as seen by the light microscope, covered with a finely reticulate perispore as seen with S.E.M.

*Type species:* *Parathelypteris glanduligera* (KUNZE) CHING.

*Distr.* c. 15 species; tropical and subtropical S.E. Asia and Malesia, N. America.

*Cytol.* n = 27 (*P. cystopteroides* (EATON) CHING, *P. noveboracensis* (L.) CHING); n = 31 (*P. beddomei*); n = 32 or 31 (*P. simulata* (DAVENP.) NIEUWL.).

*Taxon.* In his original list of species, CHING included several which I have separated as *Coryphopteris*, also *Aspidium immersum* BL. (*Amphineuron immersum* HOLTUM). In addition to species

from Asia, he added *P. noveboracensis* from North America which in habit is similar to *P. beddomei* of Malasia. He did not include another North American species, originally named *Aspidium simulatum* DAVENP. which is very similar to the type species *P. glanduligera* and has been made the type of a new genus *Wagneriopteris* by LÖVE and LÖVE, who reported a chromosome number 31 for it, though two previous authors had reported 32. In any event, the species here brought together are certainly not uniform in chromosome number, and it seems probable that the genus should be subdivided, but a new comprehensive study of all characters (including gametophytes) is necessary before this can be satisfactorily effected.

## KEY TO THE SPECIES

1. Basal pinnae, several pairs, gradually reduced, lowest 3–5 mm long . . . . . 1. *P. beddomei*
1. Basal pinnae, at most 2 pairs, slightly reduced.
  2. Pinnae to 7.5 cm long; basal pinnae much narrowed at base . . . . . 2. *P. glanduligera*
  2. Pinnae to 2.0 cm long; basal pinnae not narrowed at base . . . . . 3. *P. grammitoides*

**1. *Parathelypteris beddomei* (BAK.) CHING**, Acta Phytotax. Sinica 8 (1963) 302; C. M. KUO, Fl. Taiwan 1 (1975) 421, pl. 146. — *Lastrea gracilescens sensu* BEDD. Ferns S. India (1863) t. 110. — *Nephrodium beddomei* BAK. Syn. Fil. (1867) 267, nom. nov. — *Lastrea beddomei* (BAK.) BEDD. Ferns Brit. India corr. (1870) 2; Handb. (1883) 239; COPEL. Fern Fl. Philip. (1960) 321. — *Dryopteris beddomei* (BAK.) O. KTZE, Rev. Gen. Pl. 2 (1891) 812; v.A.v.R. Handb. (1908) 191; BACKER & POSTH. Varenfl. Java (1939) 37. — *Thelypteris beddomei* (BAK.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 6 (1936) 308; HOLTUM, Rev. Fl. Mal. 2 (1955) 240; MANTON & SLEDGE, Phil. Tr. R. Soc. B. 238 (1954) 137; K. IWATS. Mem. Coll. Sci. Univ. Kyoto B. 31 (1965) 166. — Type: BEDDOME s.n. Nilgiri Mts, S. India (K).

*Phegopteris smithii* v.A.v.R. Bull. Dép. Agr. Ind. Néerl. 18 (1908) 15; Handb. (1908) 490. — Type: Java, Gedeh, Herb. Bog. 4170 (BO).

*Dryopteris beddomei* var. *nadiwonensis* v.A.v.R. Bull. Jard. Bot. Btzg II, 7 (1912) 13. — Type: VERMOESEN, Java, Ngadiwono (BO).

*Dryopteris microcarpa* v.A.v.R. Bull. Jard. Bot. Btzg III, 2 (1920) 147. — *Thelypteris microcarpa* (v.A.v.R.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 252. — Type: BÜNNEMEIJER 5636, Sumatra, Padang Highlands (BO). — Fig. 5a–b.

## KEY TO THE VARIETIES

1. Rhizome long-creeping; septate hairs many on lower surface.
  2. Pinnae commonly 3–5 cm long
    - a. var. *beddomei*
    2. Pinnae not over 2 cm long. b. var. *eugracilis*
  1. Rhizome usually short-creeping; few septate hairs . . . . . c. var. *brassii*

a. var. *beddomei* — Fig. 5a–b.

Rhizome long-creeping, 2.5 mm diameter, bearing fronds 2–4 cm apart; scales broad, entire, with superficial capitate hairs only. Stipe 5–10 cm long, green; rachis with capitate hairs on lower surface,

usually also acicular hairs. Lamina commonly 20–25 cm long; pinnae many pairs, several pairs towards base gradually smaller, lowest less than 1 cm long. Largest pinnae 3–5 cm long, 6–8(–10) mm wide, incised almost to costa into oblique = dentate lobes 1.5–2.0 mm wide (basal lobes of largest pinnae sometimes almost free and rather deeply lobed, as in var. *nadiwonensis* v.A.v.R.); lower surface of costa, costules and veins bearing erect slender hairs 1 mm long, many consisting of several cells, and scattered very short capitate hairs or larger sessile yellow glands; upper surface sometimes also with sessile glands between veins; veins pinnate in the pinna-lobes, very oblique, simple or (in largest lobes) forked. Sori small, close to margin; indusia small bearing short capitate hairs.

Distr. Southern India & Ceylon; Taiwan: throughout Malasia.

Ecol. On mountains at 1500–2000 m, in rather open places, on sloping ground where there is a seepage of water; becoming more abundant with increased felling of mountain forest.

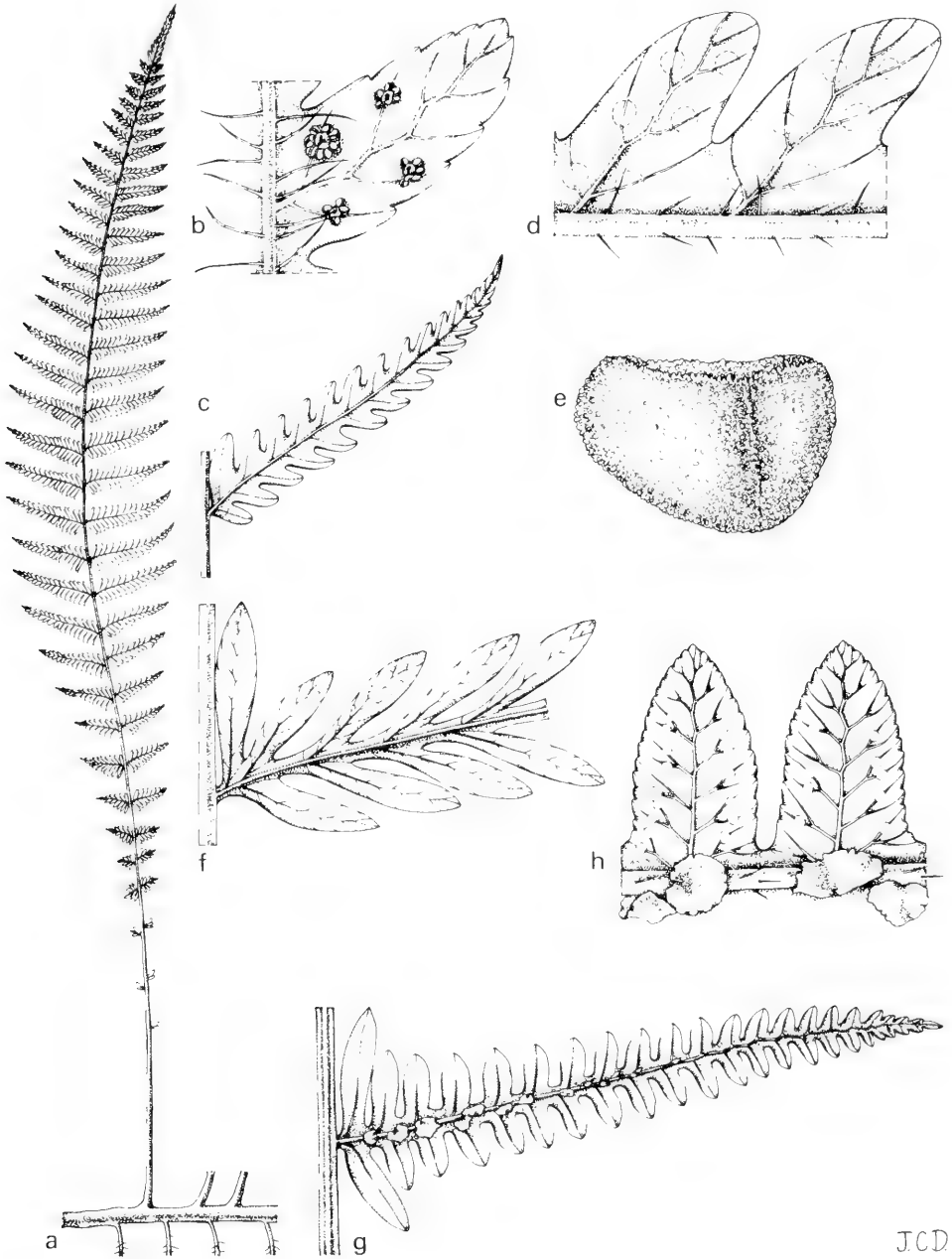
Note. Specimens from Japan and China named *T. beddomei* in Herb. Kew. appear to me to be *P. nipponica* (Fr. & SAV.) CHING; they have pinna-lobes which are flat when dried and at maturity are covered beneath with sori, and their septate hairs are shorter, consisting of at most 3 cells.

b. var. *eugracilis* (COPEL.) HOLTUM, comb. nov. — *Dryopteris gracilis* COPEL. Philip. J. Sci. 40 (1929) 294, non DOMIN, 1929. — *Lastrea eugracilis* COPEL. Gen. Fil. (1947) 138, nom. nov.; Fern Fl. Philip. (1960) 321. — *Thelypteris eugracilis* (COPEL.) REED, Phytologia 17 (1968) 275. — Type: ELMER 11520, Mindanao, Mt Apo (MICH; K. L).

Differs from var. *beddomei*: pinnae 1.4–1.6 cm long, 4–6 mm wide near base.

Distr. Malesia: Philippines (Mindanao), 2 collections, 1700–1800 m.

c. var. *brassii* (C. CHR.) HOLTUM, comb. nov. — *Dryopteris brassii* C. CHR. Brittonia 2 (1937)



JCD

Fig. 5. *Parathypteris beddomei* (BAK.) CHING. a. Rhizome and frond,  $\times \frac{1}{3}$ ; b. pinna-lobe,  $\times 12$ . — *Trigonospora ciliata* (BENTH.) HOLTUM. c. One pinna,  $\times 1.5$ ; d. 2. pinna-lobes,  $\times 8$ ; e. spore,  $\times 650$ . — *T. calcarata* (BL.) HOLTUM. f. One pinna,  $\times 2$ . — *Thelypteris confluens* (THUNB.) MORTON. g. One pinna,  $\times 8$  (a–b HOLTUM 26217, c–e HOLTUM 31306, f Java in Herb. Hook., g–h IWATSUKI et al. 155).



295. — *Lastrea brassii* (C. CHR.) COPEL. Philip. J. Sci. 78 (1951) 424. — *Thelypteris brassii* (C. CHR.) REED. Phytologia 17 (1968) 265. — Type: BRASS 4937, Papua, Mt Tafa, 2400 m (BM).

Differs from *var. beddomei*: rhizome usually short, with fronds  $\pm$  tufted; septate hairs on lower surface few and shorter.

Distr. *Malesia*: Eastern New Guinea, at 2000–3500 m.

Note. Some specimens have a partly creeping rhizome but in almost all cases some fronds are in rather dense tufts. It is possible that this variety represents an adaptation to conditions at higher altitudes and in more exposed places than the normal habitats for *var. beddomei* in Western *Malesia*. CHRISTENSEN wrongly stated that the type is exindusiate.

2. *Parathelypteris glanduligera* (KUNZE) CHING. Acta Phytotax. Sinica 8 (1963) 303; HOLTUM, Kalikasan 5 (1976) 113. — *Aspidium glanduligerum* KUNZE, Analecta Pterid. (1837) 44. — *Lastrea gracilescens var. glanduligera* BEDD. Handb. Suppl. (1892) 51. — *Dryopteris glanduligera* (KUNZE) CHRIST. J. de Bot. 21 (1908) 231. — *Thelypteris glanduligera* (KUNZE) CHING. Bull. Fan Mem. Inst. Biol. Bot. 6 (1936) 320; K. IWATS. Mem. Coll. Sci. Univ. Kyoto B, 31 (1965) 167. — Type: C. W. PETERSEN, near Canton ("Herb. Lehmann et propria"; not found among KUNZE specimens at B).

*Dryopteris repentula* CHRIST. Notul. Syst. 1 (1909) 29. — Lectotype (CHING, l.c. 1936): HENRY 13077, Yunnan (K).

Rhizome to 3 mm diameter. Stipe to 30 cm long, slender, with many capitate and sometimes acicular hairs. Lamina 20–30 cm long; pinnae 15–20 pairs, well spaced; basal pinnae not reduced, distinctly narrowed towards their bases, basal acroscopic lobe often  $\pm$  elongate and sometimes dentate. Largest pinnae 6–8.5 cm long, 1.3–1.5 cm wide, acuminate, lobed to 0.5 mm from costa; lobes entire, subacute, falcate; costules 2–3 mm apart; veins to 8 pairs, usually simple; lower surface of rachis and costae densely hairy, hairs erect, of varied length to 1 mm; hairs on costules and veins more sparse, also some small scales with swollen red terminal cell; large orange-red glands present on and between veins; upper surface lacking hairs and glands between veins. Sori near apices of veins, rather small, distal ones sometimes asymmetric; indusia small, bearing glands (often many) and short hairs.

Distr. Nepal eastwards to S. China, Korea and Japan, and south to Thailand and N. *Malesia*: Philippines (N. Luzon).

Note. The only known *Malesian* specimens are from Baguio at 1200 m (M. G. PRICE 1583) and Zambales Province, above Palauig (PRICE 2828, 2850). In 1976 I wrongly referred the Zambales specimens to *P. grammitoides*.

3. *Parathelypteris grammitoides* (CHRIST) HOLTUM, Kalikasan Philip. J. Biol. 5 (1976) 114. — *Aspidium grammitoides* CHRIST. Bull. Herb. Boiss. 6 (1898) 193. — *Thelypteris grammitoides* (CHRIST) CHING. Bull. Fan Mem. Inst. Biol. Bot. 6 (1936) 317. — *Lastrea grammitoides* (CHRIST) COPEL. Fern Fl. Philip. (1960) 320. — Type: LOHER 890. Nov. 1893. Luzon, Mt Mariveles (P: K).

*Athyrium hyalostegium* COPEL. Philip. J. Sci. 1 (1906) Suppl. 253. — Lectotype: COPELAND 2033, Luzon, Mt Mariveles (MICH; P. US).

Rhizome to 2 mm diameter. Stipes not widely-spaced, 3–10 cm long, with acicular hairs 0.3 mm long throughout; basal scales narrow, 1.5 mm long, bearing small glands, distal ones bearing also short acicular hairs. Lamina 5–8 cm long; pinnae 6–8 pairs; lowest pinnae not or little smaller than next pair, not narrowed at base, basal acroscopic lobe always free and  $\pm$  crenate, basal basiscopic lobe usually also free; apex of lamina gradually attenuate. Largest pinnae 2.0  $\times$  0.8 cm, lobed almost to costa; basal acroscopic lobe almost at right angles to costa, basiscopic and other acroscopic lobes at c. 45°, with sinuous edges; apex of pinna evenly attenuate; costules to 3 mm apart; veins 4–5 pairs in largest lobes; lower surface of rachis and costae bearing scattered slender hairs of mixed length to 1 mm long, glands present on and between veins; hairs on upper surface of costae 0.5 mm long, few hairs on costules. Sori suprasedial to medial; indusia small, thin, with rather long slender hairs and a few glands.

Distr. *Malesia*: Philippines (Luzon).

Ecol. At 900–1400 m; on Mt San Cristobal found "at edge of crater lake, in shade with mosses" (M. G. PRICE).

Note. This species is closely allied to *P. angustifrons* (MIQ.) CHING from the Ryukyu Islands and Taiwan, but the Philippine plants appear always to be much smaller than those from Taiwan. *P. cryopteroides* (EATON) CHING in Japan and the northern Ryukyu Islands is also closely related.

## 7. TRIGONOSPORA

HOLTUM, Blumea 19 (1971) 29; Reinwardtia 8 (1974) 503. — *Pseudocyclosorus* CHING, Acta Phytotax. Sinica 8 (1963) 322, p.p. — Fig. 5c–f.

Caudex short, erect; lamina of fronds commonly to 20 cm long, lacking

reduced basal pinnae; veins in Malesian species free, unbranched, lowest acroscopic vein ending beside short sinus-membrane, basal basiscope vein to edge above base of sinus; acicular unicellular hairs variously developed on lower surface; sori indusiate; glands and hairs lacking on body of sporangium, on its stalk usually a hair of several cells ending in a gland; spores trilete, minutely papillose.

Type species: *Trigonospora ciliata* (BENTH.) HOLTUM.

Distr. Ceylon, India except north-west, Burma to Kwangtung and southwards to Malesia; in Malesia: Malaya northwards from 4°N, N. Sumatra, S. Sumatra and Java, N. Celebes. About 8 species, not yet all described.

Ecol. On rocks in and beside streams in mountain forest.

Cytol. Base chromosome number 36: *T. ciliata* diploid in Malaya; species of uncertain identity diploid and tetraploid in Ceylon and S. India.

Notes. This is the only group of species in the family in which trilete spores are normal, though such have been observed as occasional in *Macrothelypteris* (P. CHANDRA, Amer. Fern J. 63, 1973, 9). In their shape and in their minutely papillose perispore they are closely similar to the spores of the monotypic African genus *Menisorus* ALSTON which are either spherical or monolete with a short laesura. Plants of *Menisorus* also have a short erect caudex and grow on rocks in streams; I believe that the two genera are related. An unnamed species in Ceylon has short capitate hairs, like those of *Pseudocyclosorus*, on the lower surface and on indusia.

In India and Ceylon this genus is much diversified in shape and size of fronds and of their pinnae, and in pubescence, but (apart from *T. zeylanica* CHING) individual species have not yet been clearly distinguished, probably because intermediates bridge some of the gaps between them. The existence of a tetraploid in S. India indicates hybridization; the habitat on wet rocks would facilitate this. One Ceylon specimen is very like *T. calcarata* of Java in shape of pinnae but much larger; others in Ceylon are very different. Hooker included most Indian specimens in *Nephrodium calcaratum*; BEDDOME added *N. falcilobum* HOOK. (*Pseudocyclosorus falcilobus* CHING) as a variety, though it differs in its reduced basal pinnae. HOOKER cited the type of *T. zeylanica* as a variety under *N. falcilobum* and expressed uncertainty as to a distinction between *N. calcaratum* and *N. falcilobum*.

*Thelypteris khamptorum* HOLTUM (Kew Bull. 26, 1971, 82) has crenate pinnae and anastomosing veins, but agrees in spores with *Trigonospora*; two collections are known from Upper Burma.

#### KEY TO THE SPECIES

1. Edges of pinnae lobed to less than 1 mm from costa, lobes narrow with wide sinuses between them; indusia glabrous.
2. Pinnae 3-4 cm long, 10-12 mm wide above auricled base; lobes (except basal acroscopic one) not narrowed towards their bases . . . . . 1. *T. calcarata*
2. Pinnae to 8 × 2 cm, basal acroscopic lobe not much elongate; pinna-lobes widest 1/3 from their apices . . . . . 2. *T. koordersii*
1. Edges of pinnae lobed to 1.5-2 mm from costa; lobes wider than sinuses between them; indusia hairy . . . . . 3. *T. ciliata*

1. *Trigonospora calcarata* (BL.) HOLTUM, Reinwardtia 8 (1974) 506. — *Aspidium calcaratum* BL. Enum. Pl. Jav. (1828) 159; RACIB. Fl. Btzig 1 (1898) 170. — *Nephrodium calcaratum* (BL.) HOOK. Spec. Fil. 4 (1862) 93, p.p. — *Dryopteris calcarata* (BL.) O. KTZE, Rev. Gen. Pl. 2 (1891) 812; v.A.v.R. Handb. (1908) 185, p.p.; BACKER & POSTH. Varenfl. Java (1939) 38. — *Thelypteris calcarata* (BL.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 6 (1936) 288. — Type: BLUME, Java (L).

*Aspidium reinwardtianum* KUNZE ex METT. Farngett. IV (1858) 86. — Lectotype (HOLTUM 1974): ZOLLINGER 1600 (B; FI, G).

*Dryopteris marthae* v.A.v.R. Bull. Jard. Bot.

Btzig II, 1 (1911) 7. — Type: BACKER 262, G. Slamet, 900 m (BO). — Fig. 5f.

Stipe 8-20 cm long, dark at base, glabrescent except in groove. Lamina 10-20 cm long; pinnae to 12 pairs. Largest pinnae 3-4 cm long, 10-12 mm wide above base, lobed to less than 1 mm from costa; lobes c. 8 pairs, narrow, very oblique except basal acroscopic one which is elongate, close to rachis and almost free; veins c. 6 pairs; rachis, costae and costules sparsely hairy on lower surface. Sori near costules; indusia dark, firm, glabrous; sporangia lacking gland-bearing hairs on their stalks.

Distr. Ceylon and Malesia: throughout Java at

100–1000 m, southern Sumatra and north to Padang Highlands.

**2. *Trigonospora koordersii*** (CHRIST) HOLTUM, *Reinwardtia* 8 (1974) 506. — *Aspidium koordersii* CHRIST, *Ann. Jard. Bot. Batz* 15 (1897) 128, t. 15, f. 17. — *Dryopteris koordersii* (CHRIST) C. CHR. Ind. Fil. (1905) 273; v.A.v.R. Handb. (1908) 181. — Type: KOORDERS 1700, Celebes, near Karawutu, 50 m (P; BO, L).

*Stipe* 15 cm, glabrous. *Lamina* to 24 cm long; pinnae 8 pairs. *Largest pinnae* 8 × 2 cm, distinctly stalked, lobed almost to costa; lobes at 45°, to 15 mm long, 1½–2 mm wide, widest 1/3 from apex and narrowed towards base, basal acroscopic lobe not much longer than next; sparse rather thick hairs on lower surface of costules only; veins 8–12 pairs. *Sori* medial; indusia firm, dark, glabrous; sporangia short-stalked, lacking a glandular hair on the stalk.

*Distr. Malesia*: N.E. Celebes; only known from the type.

**3. *Trigonospora ciliata*** (BENTH.) HOLTUM, *Blumea* 19 (1971) 29. — *Lastrea ciliata* HOOK. J. Bot. Kew Misc. 9 (1857) 338, non LIEBM. — *Aspidium ciliatum* BENTH. Fl. Hongkong. (1861) 455. — *Lastrea calcarata* var. *ciliata* BEDD.

Handb. (1883) 235, p.p. — *Dryopteris ciliata* (BENTH.) C. CHR. ex WU et al. Bull. Dept. Biol. Sunyatsen Univ. n. 3 (1922) 30, pl. 6. — *Thelypteris ciliata* (BENTH.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 6 (1936) 289; C.C. WOOD, J. Linn. Soc. Bot. 67, Suppl. 1 (1973) pl. 2C. — *Pseudocyclosorus ciliatus* (BENTH.) CHING, Acta Phytotax. Sinica 8 (1963) 324. — Lectotype (HOLTUM 1974): "BOWMAN" (BOWRING), Hong Kong (K).

*Dryopteris pinnata* COPEL. Univ. Cal. Publ. Bot. 14 (1929) 373. — *Thelypteris pinnata* (COPEL.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 253. — Type: BARTLETT 6641, Sumatra, Asahan river (UC; L). — Fig. 5c–e.

*Stipe* of sterile fronds 10–15 cm, of fertile to 25 cm long. *Lamina* to 20 cm long; pinnae c. 14 pairs. *Largest pinnae* 4–5 cm long, 1.0–1.2 cm wide above the base, lobed to 1.5–2 mm from costa; lobes oblique, rather triangular, basal acroscopic lobe a little elongate; veins 5–6 pairs; lower surface of rachis and costae bearing copious soft pale spreading hairs 1 mm long, shorter ones on costules and veins. *Sori* near costules; indusia large, very hairy; stalk of sporangium bearing a hair of 3 cells, end cell glandular.

*Distr.* N. India and S. China southwards to *Malesia*: N. Malaya and Sumatra.

## 8. THELYPTERIS

SCHMIDEL, Icon. Pl. ed. Keller (1763) 45, t. 11, 13, *nom. cons.*; FERNALD, *Rhodora* 31 (1929) 27–36, pl. 179–180; CHING, Acta Phytotax. Sinica 8 (1963) 297 *excl. T. grisea* (BAK.) CHING; HOLTUM, Taxon 17 (1968) 330; *Blumea* 19 (1971) 28; A.F. TRYON, *Rhodora* 73 (1971) 444. — Fig. 5g–h.

Rhizome long-creeping, in wet ground; fronds simply pinnate with deeply lobed pinnae, basal ones not reduced; veins free, usually forked, all reaching margin; flat thin scales present on lower surface of costae; sori indusiate; sporangia bearing short capitate hairs; perispore of spores varied (see A.F. TRYON l.c.).

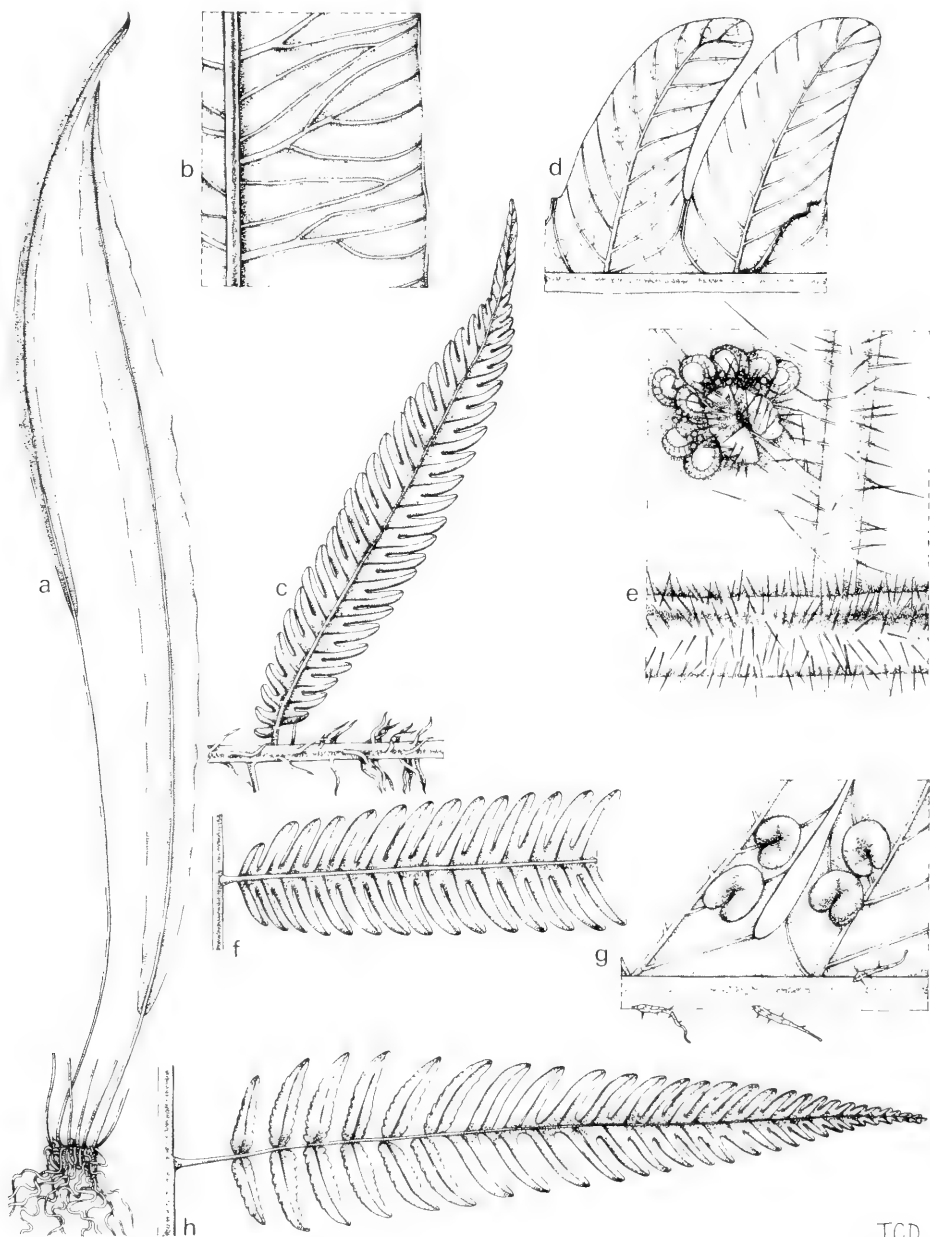
Type species: *Thelypteris palustris* SCHOTT.

*Distr.* North temperate Eurasia, in Asia south to Himalayas; eastern temperate and subtropical N. America; Africa south of the Sahara; S. India; N. Thailand; in *Malesia*: Sumatra and New Guinea; New Zealand. Two species, northern and southern, the former with geographically distinct subspecies.

Cytol. Base chromosome number 35; many observations in north temperate regions, all diploid.

Notes. This genus, as restricted by CHING but excluding his *T. grisea*, is the temperate counterpart of *Cyclosorus* (in the restricted sense here adopted). Both are rhizomatous ferns growing in open fresh-water swamps. They also agree in having fronds with unreduced basal pinnae and in bearing flat scales on lower surface of costae, a character uncommon in the family. In the present work, *Cyclosorus* is associated with *Ampelopteris* and *Mesophlebion*; from these three *Thelypteris* differs in (a) capitate hairs on sporangia, (b) lack of red glands at the ends of hairs on sporangium-stalk, (c) chromosome number 35, (d) basisopic vein always from costule, not from costa. But I suggest that *Thelypteris* is nearest to this group of genera.

CHING included *Nephrodium griseum* BAK. (see BEDD. Ferns Brit. India t.335, Handb. 241) as a species of his restricted *Thelypteris*. The type of this is a specimen at Kew from Cochin which resembles *T. palustris* in its forked veins but in little else. BEDDOME wrote a note on it in his own Herbarium (now at Kew) and suggested that it was probably an abnormal form of *Lastrea calcarata* var.



JCD

Fig. 6. *Mesophlebion oligodictyon* (BAK.) HOLTUM. a. Whole plant,  $\times \frac{1}{2}$ ; b. venation of sterile frond,  $\times 4$ . — *M. trichopodum* (C. CHR.) HOLTUM. c. Rachis and basal pinna,  $\times \frac{1}{2}$ ; d. two pinna-lobes, hairs omitted,  $\times 4$ ; e. costa, costule and sori,  $\times 24$ . — *M. beccarianum* (CESATI) HOLTUM. f. Suprabasal pinna,  $\times \frac{1}{2}$ ; g. venation and sori,  $\times 8$ . — *M. endertii* (C. CHR.) HOLTUM. h. One pinna,  $\times \frac{1}{2}$  (a JACOBS 5600, b C. HOSE 210, c-e MATTHEW s.n., f-g LEE & MAHMUD UL37, h ENDERT 4433).

*ciliata* (*Trigonospora ciliata* of the present work) but in my opinion it is an abnormal form of a species of *Pseudocyclosorus*.

The best account of the genus in the northern hemisphere is by FERNALD, *l.c.*

**1. *Thelypteris confluens*** (THUNB.) MORTON, Contr. U.S. Nat. Herb 38 (1967) 71; SCHELPE, Fl. Zambes. Pterid. (1970) 190, t. 55E; HOLTUM, J.S. Afr. Bot. 40 (1974) 150; Allertonia 1 (1977) 180. — *Pteris confluens* THUNB. Prodr. Fl. Cap. (1800) 171. — Type: THUNBERG, S. Africa (UPS).

*Aspidium thelypteris* var. *squamigerum* SCHLECHTEND. Adumb. Fil. Prom. B. Spei (1825) 23, t.11. — *Aspidium squamigerum* FÉE, Mém. Fam. Foug. 8 (1857) 104. — *Lastrea thelypteris* var. *squamigera* BEDD. Handb. Suppl. (1892) 54. — *Dryopteris thelypteris* var. *squamigera* C. CHR. Ind. Fil. (1905) 297. — *T. palustris* var. *squamigera* WEATH. Contr. Gray Herb. n.s. 73 (1924) 40. — *T. squamigera* (err. typ. *squamulosa*) CHING, Bull. Fan Mem. Inst. Biol. Bot. 6 (1936) 329; TARD. in Humbert, Fl. Madag. 5e Fam. 1 (1958) 282. — Type: SCHLECHTENDAL, Cape Peninsula (HAL).

*Nephrodium squamulosum* HOOK. f. Fl. New Zeal. 2 (1855) 39. — *Nephrodium thelypteris* var. *squamulosum* HOOK. Spec. Fil. 4 (1862) 88. — Type: COLENSO, New Zealand (K).

*Lastrea fairbankii* BEDD. Ferns Br. Ind. (1867) t.254; Handb. (1883) 240. — Type: BEDDOME, S. India, Pulney Hills (K). — Fig. 5g-h.

*Rhizome* 2 mm diameter (dry). *Stipe* stramineous, 15–50 cm long. *Lamina* 25–50 cm long; pinnae to 20 pairs or more, dimorphous. *Sterile pinnae* commonly 4–6 × 1.5 cm, *fertile* 6–9 mm wide; lowest pinnae slightly reduced, sometimes with a free basal acroscopic lobe; middle pinnae not dilated at base, lobed to less than 1 mm from costa; veins in sterile fronds mostly forked, in fertile often simple; lower surface of costae bearing slender hairs and ovate-orbicular flat ciliate scales 0.5–1 mm long and wide; lower surface between veins bearing a variable number of slender acicular and short capitate hairs; hairs on upper surface of costa short. *Sori* near costules; indusia with short marginal hairs.

Distr. Africa south of the equator and to 7°N in Ethiopia and Sudan; Madagascar; S. India; N. Thailand and Laos; in *Malesia*: N. Sumatra in Atjeh, near Lake Toba and near G. Kerinci; Western New Guinea on Arfak Mts, Eastern New Guinea in W. Highlands; New Zealand (North Island).

Ecol. In N. Sumatra at 1180–1330 m, in W. New Guinea at 1750–1900 m, in E. New Guinea at 2500 m; in all cases in swampy open ground near lakes.

## 9. MESOPHLEBION

HOLTUM, Blumea 19 (1971) 29 (new name for *Mesoneuron* CHING, non DESF.), excl. subg. *Plesioneuron*. — Group of *Dryopteris crassifolia* (BL.) O. KTZE, C. CHR. Gard. Bull. Str. Settl. 4 (1929) 381; of *Thelypteris crassifolia* (BL.) CHING, HOLTUM, Rev. Fl. Mal. 2 (1955) 245–249, f. 139–141. — *Mesoneuron* CHING, Acta Phytotax. Sinica 8 (1963) 325, excl. *M. attenuatum*. — *Thelypteris* subg. *Glaphyropteridopsis* sect. *Mesoneuron* K. IWATS. Mem. Coll. Sci. Univ. Kyoto B, 31 (1964) 30, excl. *Pseudocyclosorus* CHING. — Fig. 1k, 6.

Caudex creeping, sometimes elongate; scales narrow, rather rigid but never spine-like, bearing short acicular hairs; similar scales at base of stipe, in a few species throughout stipe and basal part of abaxial surface of rachis. Fronds simply pinnate (in *M. oligodictyon* simple, in *M. endertii* partly bipinnate), sometimes dimorphic; basal pinnae not reduced but ± narrowed towards their asymmetric bases; aerophores often distinctly swollen on living fronds, collapsing on drying; all pinnae lobed, in some cases deeply; veins all simple and free (except casually in *M. oligodictyon* and *M. motleyanum*), basal basisopic vein arising from costa near the base of the costule to which it belongs; basal veins from adjacent costules usually both passing to base of sinus between their lobes, touching sides of the sinus-membrane, which may be slightly decurrent between them as a hairy ridge; lower surface of costae, costules and veins always bearing many narrow

scales in various degrees of reduction (smallest of 2 or 3 cells) in addition to a varied complement of acicular unicellular (sometimes also capitate) hairs and in some cases sessile spherical orange glands; upper surface hairy on costa only; sori in almost all cases indusiate, the indusia in most cases thin and sometimes small; young sporangia often pale violet-purple; large spherical orange-red glands attached directly or by a hair to stalks of sporangia, no glands nor hairs on body of sporangia; spores in most species with a thin continuous wing and a few cross-wings, papillose without a wing in *M. beccarianum* and *M. chlamydophorum*.

Type species: *Mesophlebion crassifolium* (BL.) HOLTUM.

Distr. Peninsular Thailand and southern Burma, *Malesia*: except E. Java and Lesser Sunda Islands (greatest diversity in Borneo), few specimens from New Guinea.

Ecol. In forest, apart from *M. teuscheri* and *M. arenicola* (on wet sandstone in exposed places) and *M. oligodictyon* (in rocky stream-beds), at 0–1500 m.

Cytol. Base chromosome number 36; *M. crassifolium* and *M. trichopodium* both tetraploid in Malaya (MANTON in Holtum 1955), *M. falcatilobum* diploid in Sarawak (T. G. WALKER, new obs.)

Taxon. Species of this genus were first recognized as forming a distinct group by CHRISTENSEN (1929). CHING transferred two of them to *Thelypteris* in 1936, and the species of Malaya were treated under that genus by HOLTUM in 1955. In 1963 CHING established the genus *Mesoneuron* for them, but as *Mesoneuron* DESF. has also been spelled *Mesoneuron* I proposed the new name *Mesophlebion* in 1971; in doing so I included *Plesioneuron* as a subgenus.

*Mesophlebion* agrees with *Cyclosorus* (in the strict sense of the present account) and *Ampelopteris* in the large red glands which occur at the ends of hairs on stalks of sporangia and sometimes on the lower surface of veins, also in the presence of scales on the lower surface of costae. In my judgement, these two genera and *Thelypteris* are the only near relatives of *Mesophlebion*.

In tropical America occur two species which CHRISTENSEN (Monogr. Dryopteris 1, 1913, 170–173) placed with doubt in *Dryopteris* subg. *Steiropteris*; BAKER confused *Mesophlebion motleyanum* with one of these and was copied by other authors. The American species differ from *Mesophlebion* in having a long sinus-membrane and long aerophores, and in the absence of red glands.

Several species of *Mesophlebion* are variable, and it is possible that a complex of diploids, triploids and tetraploids may exist. Experimental studies are needed to clarify this situation. I judge that the species here recognized are reasonably distinct, though probably not all of equal status, and hybrids may occur. Several plants of both *M. motleyanum* and *M. falcatilobum*, from Gunong Mulu in Sarawak, have shown consistently distinct characters in cultivation at Kew.

It is notable that, as in *Plesioneuron* and *Chingia*, a few species of this genus have abundant scales throughout the stipe and at least the basal part of the rachis. This development in the three genera appears to be a case of parallel evolution; a similar condition occurs in one non-Malesian species of *Christella* (*C. crinipes* (HOOK.) HOLTUM) to which RIDLEY referred specimens of *M. trichopodium*.

#### KEY TO THE SPECIES

1. Stipe and lower part of rachis bearing numerous stiff spreading scales.
2. Pinnae to 12 cm long.
  3. Stipe-scales dark, to 1 mm wide; veins 7–10 pairs . . . . . 1. *M. echinatum*
  3. Stipe-scales medium brown, to 2 mm wide; veins 12–17 pairs . . . . . 2. *M. persquamiferum*
2. Pinnae of well-grown plants much longer.
  4. Costae, costules and veins beneath bearing short hairs only; stipe-scales to 6 mm long.
    5. Lower pinnae not auricled; no glands on lower surface of costules . . . . . 3. *M. hallieri*
    5. Lower pinnae strongly auricled; copious glands on lower surface of costules . . . . . 4. *M. caroli*
  4. Costae, costules and veins beneath bearing hairs 1 mm or more long, at least on sterile fronds; stipe-scales 10 mm or more long . . . . . 5. *M. trichopodium*
1. Upper part of stipe and rachis lacking large scales.
  6. Fronds simple . . . . . 6. *M. oligodictyon*
  6. Fronds pinnate or partly bipinnate.
    7. Pinnae not more than 3 cm long.
      8. Pinnae lobed less than half-way to costa; acroscopic bases of pinnae auricled . . . . . 7. *M. teuscheri*
      8. Pinnae lobed more than half-way to costa, not auricled . . . . . 8. *M. arenicola*

7. Pinnae much longer.
9. Largest pinnae with several pairs of pinnules . . . . . 9. *M. endertii*
9. Largest pinnae with at most one free basal lobe.
10. Sterile pinnae lobed not more than half-way to costa, except sometimes basal pinnae.
11. Pinnae 6-8(-10) pairs; young fronds red . . . . . 10. *M. motleyanum*
11. Pinnae 14-18 pairs; young fronds not red . . . . . 11. *M. falcatilobum*
10. Sterile pinnae lobed more than half-way to costa.
12. Pinnae to 6.5 cm wide, lower ones with stalks 3-4 cm long . . . . . 12. *M. dulitense*
12. Pinnae not more than 4 cm wide, lower ones with stalks to 1.5 cm long.
13. Hairs on lower surface of costae and costules c. 1 mm long.
14. All pinnae distinctly stalked; copious short hairs and glands between veins on lower surface . . . . . 13. *M. auriculiferum*
14. Pinnae sessile; sparse erect hairs 0.5 mm long and no glands between veins on lower surface . . . . . 5. *M. trichopodium*
13. Hairs on lower surface of costae and costules not over 0.3 mm long.
15. Indusia firm, glabrous, covering the sorus almost to maturity; fertile pinnae lobed to 1-1½ mm from costa . . . . . 14. *M. beccarianum*
15. Indusia small, not covering developing sori, or ± hairy; fertile pinnae lobed less deeply.
16. Fertile pinnae lobed to 2 mm from costa; indusia small, firm, glabrous . . . . . 15. *M. rufescens*
16. Fertile pinnae lobed less deeply; indusia usually with some hairs, thin and almost obscured by sporangia if small.
17. Fronds rarely dimorphic; pinnae thin, rarely more than 2 cm wide; indusia always conspicuous, firm, bearing a variable number of short hairs . . . . . 16. *M. chlamydophorum*
17. Fronds usually dimorphic; pinnae rigid, fertile to 3 cm, sterile to 4 cm wide; indusia varied in size, thin and shrivelling when dried . . . . . 17. *M. crassifolium*

**1. *Mesophlebion echinatum* (METT.) HOLTNUM,** Blumea 22 (1975) 226. — *Aspidium echinatum* METT. Ann. Mus. Bot. Lugd.-Bat. 1 (1864) 230; MIQUEL, *ibid.* 4 (1868) 157. — *Dryopteris echinata* (METT.) O. Ktze, Rev. Gen. Pl. 2 (1891) 812; v.A.v.R. Handb. (1908) 182; C. Chr. Gard. Bull. Str. Settl. 4 (1929) 386. — *Mesoneuron echinatum* (METT.) CHING, Acta Phytotax. Sinica 8 (1963) 326. — *Thelypteris echinata* (METT.) REED, Phytologia 17 (1968) 274. — Type: KORTHALS 498, G. Prarawin, near Bandjermasin, Kalimantan (L. n. 908, 335-575).

*Caudex* short-creeping; *stipe* to 30 cm long, bearing throughout (also basal part of rachis and near bases of costae on lower surface) spreading dark scales to 10 mm long, those of *stipe* 1 mm wide at base, on rachis narrower. *Lamina* of type 30 cm long (of another specimen 70 cm); basal pinnae slightly narrowed at base with stalks 2 mm long. *Largest pinnae* 11-15 cm long, 1.5-2.0 cm wide, acuminate with subentire cauda 10-15 mm long, lobed to less than 2 mm from costa; costules 3.5 mm apart, at more than 60° to costa; veins 7-10 pairs, basal basiscopic vein arising from costa near base of its costule; rachis and costae densely short-hairy on lower surface, hairs sparse on costules and veins, large red glands present on costules. *Sori* inframedial; indusia small, firm, caducous, with a few short hairs or glabrous.

*Distr.* **Malesia:** Borneo (Kalimantan, Sarawak), N. Sumatra.

*Ecol.* Lowland forest.

*Note.* The Sumatran specimen (DE WILDE 12635) has the basal basiscopic vein arising from the costa rather far from the base of its costule.

**2. *Mesophlebion persquamiferum* (v.A.v.R.) HOLTNUM,** Blumea 22 (1975) 226. — *Dryopteris persquamifera* v.A.v.R. Bull. Jard. Bot. Btztg II, 16 (1914) 10; Handb. Suppl. (1917) 149. — *Mesoneuron persquamiferum* (v.A.v.R.) CHING, Acta Phytotax. Sinica 8 (1963) 326. — Type: RACHMAT 489, Somalilah, Celebes (BO; L).

*Aspidium echinatum sensu* CHRIST, Ann. Jard. Bot. Btztg 15 (1898) 128.

*Stipe* 35-40 cm long, densely scaly; scales medium brown, to 8 × 2 mm, with thick persistent bases; similar scales on rachis. *Lamina* 50 cm long; pinnae c. 20 pairs; basal pinnae slightly narrowed at base, short-stalked. *Largest pinnae* 12.5 × 2.0-2.5 cm; base slightly dilated, apex short-acuminate; edges lobed to 2 mm from costa, lobes falcate; costules to 4 mm apart, at more than 60°; veins 12-17 pairs, basal basiscopic vein from costa distant from its costule; rachis scaly beneath almost throughout; costae and costules almost hairless beneath with many narrow scales and sessile glands, some glands also on surface between veins. *Sori* inframedial; indusia small, short-hairy, often caducous.

*Distr.* **Malesia:** Central Celebes, 2 collections (SARASIN 952, Takale Kado, 900 m; BAS).

**3. *Mesophlebion hallieri* (CHRIST) HOLTNUM,** Blumea 22 (1975) 227. — *Aspidium hallieri* CHRIST, Ann. Jard. Bot. Btztg 20 (1905) 106. — *Dryopteris hallieri* (CHRIST) C. Chr. Ind. Fil. (1905) 269; Gard. Bull. Str. Settl. 4 (1929) 387; v.A.v.R. Handb. (1908) 184. — *Mesoneuron hallieri* (CHRIST) CHING, Acta Phytotax. Sinica 8 (1963) 326. — *Thelypteris hallieri* (CHRIST) REED, Phy-

tologia 17 (1968) 281. — Type: HALLIER 3204, Amai Ambit, W. Kalimantan (P; BO, L).

*Stipe* densely covered with short reddish hairs, also scaly throughout; scales to  $6 \times 1$  mm. *Lamina* slightly dimorphous, to 100 cm long; pinnae to 25 pairs; lowest pinnae not seen. *Largest pinnae* 23 cm long, sterile ones to 3 cm wide, fertile narrower; base of middle pinnae truncate, somewhat dilated both sides; apex acuminate with cauda to 2 cm long; edges lobed to 3 mm from costa, lobes falcate at tips; costules  $4.5\text{--}5$  mm apart, at more than  $60^\circ$ ; veins 12–15 pairs, pale and very prominent beneath, basal basiscopic vein arising far from its costule; rachis densely short-hairy on lower surface, with scales as stipe, costae short-hairy with smaller scales, some short hairs on veins and surface. *Sori* inframedial; indusia small, thin, hairy.

Distr. *Malesia*: West Borneo.

**4. *Mesophlebion caroli* HOLTUM**, *Blumea* 22 (1975) 227. — Type: C. HOSE 712, Baram district, Sarawak (K; BM).

*Caudex* not seen; *scales* on upper part of stipe and rachis medium brown, firm,  $6 \times 0.5$  mm. *Basal pinnae* much narrowed towards base both sides, with enlarged almost free basal acroscopic lobe 9 mm long, basal basiscopic lobe attached 3 mm from base of pinna; suprabasal pinnae with basal acroscopic lobe to 1.8 cm long, basiscopic 0.9 cm; upper pinnae with slightly elongate basal acroscopic lobes, basiscopic ones not reduced. *Largest pinnae*  $25 \times 2.5$  cm, caudate-acuminate with cauda 3.0 cm long, 5 mm wide; edges lobed to 2.5 mm from costa; lobes slightly falcate with rounded tips; costules  $5\text{--}5.5$  mm apart; veins to 13 pairs, basal veins touching sides of short sinus-membrane, basal basiscopic vein arising far from its costule; lower surface of rachis and costae bearing narrow scales 2–4 mm long and sparse short spreading hairs, many large red glands present on costae and costules, much-reduced scales of various sizes on costules and veins. *Sori* inframedial; indusia firm, of medium size, glabrous or rarely with a short hair.

Distr. *Malesia*: Borneo. Two collections, the second near Sambas in N.W. Kalimantan.

**5. *Mesophlebion trichopodum* (C. CHR.) HOLTUM**, *Blumea* 22 (1975) 226. — *Dryopteris trichopoda* C. CHR. Ind. Fil. (1905) 298, new name for *Nephrodium polytrichum* BAK. J. Bot. 29 (1891) 107, non SCHRAD. 1824; C. CHR. Gard. Bull. Str. Settl. 4 (1929) 397. — *Dryopteris polytricha* v.A.v.R. Handb. (1908) 187. — *Mesoneuron trichopodum* (C. CHR.) CHING, Acta Phytotax. Sinica 8 (1963) 326. — Type: G. F. HOSE s.n. Lingga Mts, Sarawak (K).

*Dryopteris paleata* COPEL. Phillip. J. Sci. 9 (1914) Bot. 228; C. CHR. Gard. Bull. Str. Settl. 4 (1929) 383, 387. — *Thelypteris paleata* (COPEL.)

HOLTUM, Rev. Fl. Mal. 2 (1955) 249, f. 141. — *Mesoneuron paleatum* (COPEL.) CHING, Acta Phytotax. Sinica 8 (1963) 326. — Type: BROOKS 136, Lebong Tandai, Benkoelen, Sumatra (MICH).

*Nephrodium crinipes sensu* RIDL. J. Mal. Br. R. As. Soc. 4 (1926) 74. — Fig. 6c–e.

*Caudex* thick, short-creeping; *stipe* 60 cm long, 1.2 cm diameter at base, densely scaly throughout, scales dark brown, rigid, commonly 10 mm long, 1–1.5 mm wide at base, some of them narrowed above base, many small scales also present. *Lamina* to 100 cm long; pinnae 20–25 pairs; basal pinnae narrowed a little near their bases, those of type  $30 \times 4.3$  cm (sterile). *Suprabasal pinnae* commonly to 20 cm long, 2.5–3.5 cm wide (sterile wider than fertile), caudate-acuminate, lobed to 3–4 mm from costa, lobes falcate, basal basiscopic lobe much longer than acroscopic and curved; costules  $4.5\text{--}5$  mm apart (fertile)  $6\text{--}7.5$  mm (sterile); veins to 23 on basiscopic side of largest sterile lobe, to 18 on fertile lobes (to 15 on acroscopic side), basal basiscopic vein arising from costa far from its costule, ends of basal veins closely parallel to each other on either side of a narrow sinus-membrane; *lower surface* of rachis densely scaly in basal part, throughout with close short hairs, costae similar, veins on sterile pinnae bearing slender hairs 1 mm long (sometimes shorter on fertile pinnae) and very short capitate hairs, sometimes also red glands. *Sori* inframedial; indusia small but conspicuous, thin, with many hairs 0.3 mm long.

Distr. *Malesia*: Borneo, Malaya, Sumatra.

Ecol. Near streams in forest, at 0–1000 m.

Notes. Specimens from Malaya are all smaller than those from Borneo and Sumatra but are otherwise not different. Some specimens from G. Mulu, Sarawak, have fewer, smaller, stipe-scales and many glands on the lower surface of veins.

**6. *Mesophlebion oligodictyon* (BAK.) HOLTUM**, *Blumea* 22 (1975) 227. — *Acrostichum oligodictyon* BAK. J. Linn. Soc. Bot. 24 (1887) 261. — *Leptochilus oligodictyus* (BAK.) C. CHR. Ind. Fil. (1905) 387; v.A.v.R. Handb. (1908) 735. — *Dryopteris oligodictya* (BAK.) C. CHR. Mitt. Inst. Allgem. Bot. Hamb. 7 (1928) 148. — *Cyclosorus oligodictyus* (BAK.) HOLTUM, *Blumea* 11 (1962) 530. — *Thelypteris oligodictya* (BAK.) REED, Phytologia 17 (1968) 298. — Type: C. HOSE 110, Sarawak, Niah (K).

*Syngamma angusta* COPEL. Philip. J. Sci. 3 (1909) Bot. 348; v.A.v.R. Handb. Suppl. (1917) 330. — Type: BROOKS s.n. July 1908, Bidi, Sarawak (MICH; BM, K). — Fig. 6a–b.

*Caudex* short-creeping, diameter 2.5–3 mm, scales 2 mm long; *stipes* closely seriate, of sterile fronds to 7 cm long, of fertile 14–18 cm. *Lamina* simple, dimorphous, gradually attenuated to both ends, entire or with slightly sinuous edges which are strongly cartilaginous. *Sterile lamina* 20–28 cm



long, 1.5–1.9 cm wide; veins thick and prominent on lower surface, usually 3 pairs to each group, basal basicopic vein arising from midrib of frond below the rest (lowest acroscopic one also sometimes from midrib), basal veins of adjacent groups anastomosing irregularly near margin; lower surface quite glabrous apart from small narrow scales at the base of each group of veins. *Fertile lamina* 20–24 cm long, 5–6 mm wide; sporangia borne all along the veins, without indusia.

Distr. *Malesia*: Borneo (Sarawak, Brunei, Kalimantan), at least 6 collections.

Ecol. On rocks in river bed, low altitudes.

Notes. The evidence that this species belongs to the genus *Mesophlebion* is provided by the gland-bearing hairs on sporangium stalks, also by the basal veins of each group arising from the midrib in the same way that basal veins of pinnate species arise from the costae below the costules.

**7. *Mesophlebion teuscheri* (v.A.v.R.) HOLT-TUM**, *Blumea* 22 (1975) 228. — *Dryopteris teuscheri* v.A.v.R. *Bull. Dép. Agr. Ind. Néerl.* 18 (1908) 6; *Handb.* (1908) 183; C. CHR. *Gard. Bull. Str. Settl.* 4 (1929) 383, p.p. — *Mesoneuron teuscheri* (v.A.v.R.) CHING, *Acta Phytotax. Sinica* 8 (1963) 326. — *Thelypteris teuscheri* (v.A.v.R.) REED, *Phytologia* 17 (1968) 319. — Type: TEUSCHER, W. Kalimantan (BO).

*Caudex* suberect; stipe 5–10 cm long, densely short-hairy, basal scales narrow. *Lamina* 15–20 cm long; pinnae 20 pairs; 2–3 pairs lower pinnae gradually a little narrowed towards their bases, basal acroscopic lobe of lowest pinnae free, entire, obovate. *Largest pinnae* 2.2 cm long, 8 mm wide above auricled base; apex obtuse; edges lobed 1/3–1/2 towards costae; costules to 2.5 mm apart; veins to 3 pairs, basal veins not quite meeting at sinus; lower surfaces short-hairy throughout, with some large red glands. *Sori* medial; indusia densely hairy; sporangia with a sessile gland on the stalk.

Distr. *Malesia*: W. Borneo; known from type collection only.

Note. CHRISTENSEN's description of 1929 was based on the original description and on small specimens of *M. beccarianum* from Borneo and *M. arenicola* from Sumatra; he had not seen TEUSCHER's specimen.

**8. *Mesophlebion arenicola* HOLTUM**, *Blumea* 22 (1975) 228. — Type: W. MEIJER 4478, Pajakumbuh-Taram, Harau Canyon, Sumatra (L).

*Caudex* short, suberect; stipe 5–15 cm long, minutely hairy with scattered longer hairs, basal scales very small, dark, with short stiff hairs. *Lamina* to 25 cm long; pinnae to 15 pairs; basal pinnae slightly reduced with stalks to 1 mm long. *Largest pinnae* 3.5 × 1.3 cm (sterile) 3.0 × 0.8 cm (fertile); base truncate, not auricled; apex a short broad tip; edges lobed to 1 mm from costa or more

deeply, lobes oblique; costules to 2.5 mm apart; veins 4 pairs, basal ones in lobes near base of pinnae both to sides of a short sinus-membrane, in distal lobes both to edge above base of sinus; lower surface of rachis and costae covered with short hairs and scattered long ones, whole lower surface of pinnae closely covered with erect short hairs, among them many sessile orange glands. *Sori* medial, filling lower surface of fertile pinnae; indusia densely hairy; sporangia with short stalks, hairs on stalks commonly of 3 cells with terminal gland.

Distr. *Malesia*: Central Sumatra (3 collections).

Ecol. On sandstone rocks with dripping water, at 500 m.

Note. The type is a small specimen with pinnae to 1.3 × 0.5 cm.

**9. *Mesophlebion endertii* (C. CHR.) HOLTUM**, *Blumea* 22 (1975) 228. — *Dryopteris endertii* C. CHR. *Dansk Bot. Ark.* 9, 3 (1937) 60, pl. V, f. 7–10. — Type: ENDERT 4433, W. Kutai, Kemul, Kalimantan (BO). — Fig. 6h.

*Stipe* 80 cm long, glabrous above base; *lamina* more than 100 cm long; pinnae 12–14 pairs, lower ones 9 cm apart. *Basal pinnae* 43 cm long with stalks 4 cm long and 15 pairs of free pinnules c. 1.5 cm apart, then some separately adnate lobes, distal part of pinnae deeply pinnatifid; basal pinnules very unequal (basicopic 2 cm, acroscopic 4 cm long); *largest pinnules* 5 × 1 cm, in basal half lobed halfway to costule; veins to 25 pairs, lower ones pinnate in the pinnule-lobes, thick and prominent, distal ones simple; short hairs present on lower surface of costae; upper pinnae normal for genus *Mesophlebion*. *Sori* small; indusia very small with a few short hairs.

Distr. *Malesia*: Borneo (E. Kalimantan: W. Kutai) known from type only.

**10. *Mesophlebion motleyanum* (HOOK.) HOLTUM** in Nayar & Kaur, *Comp. to Bedd.* (1974) 209; *Blumea* 22 (1975) 229. — *Nephrodium motleyanum* HOOK. *Syn. Fil.* (1867) 266. — *Dryopteris motleyana* (HOOK.) C. CHR. *Ind. Fil.* (1905) 278; *Gard. Bull. Str. Settl.* 4 (1929) 385. — *Dryopteris crassifolia* (BL.) O. KTZE *var. motleyana* (HOOK.) v.A.v.R. *Handb.* (1908) 182. — *Thelypteris crassifolia* (BL.) CHING *var. motleyana* CHING, *Bull. Fan Mem. Inst. Biol. Bot.* 6 (1936) 286. — *Thelypteris motleyana* (HOOK.) HOLTUM, *Rev. Fl. Mal.* 2 (1955) 247, f. 140. — Type: MOTLEY, Labuan (K).

*Dryopteris vinoscarpa* v.A.v.R. *Bull. Jard. Bot. Btzig III*, 5 (1922) 198. — *Thelypteris vinoscarpa* (v.A.v.R.) CHING, *Bull. Fan Mem. Inst. Biol. Bot.* 10 (1941) 255. — *M. vinoscarpum* (v.A.v.R.) HOLTUM, *Blumea* 22 (1975) 229. — Type: cult. Hort. Bog. leg. BROOKS, origin Lebong Tandai, Sumatra (BO; L).

*Dryopteris motleyana* var. *dulitensis* C. CHR. Gard. Bull. Str. Settl. 4 (1929) 386. — Type: MJOBERG, Mt Dulit, Sarawak (BM).

*Nephrodium brachyodus* sensu BAK. Syn. Fil. (1867) 295, p.p. *quoad pl. Malacc. tantum*; BEDD. Ferns Brit. India Suppl. (1876) 19, pl. 379; Handb. (1883) 281, p.p. excl. typ.; RIDL. J. Mal. Br. R. Asiat. Soc. (1926) 74, p.p. — *Dryopteris brachyodus* sensu V.A.V.R. Handb. (1908) 220, 819, p.p. (all descriptions based partly on specimens from Malaya).

*Caudex* short-creeping; *stipe* of sterile fronds 15–35 cm long, of fertile fronds to 50 cm, glabrescent; basal scales few, 2–3 mm long. *Lamina* red when young, 20–50 cm or more long; pinnae 6–8(–10) pairs, almost opposite; basal pinnae slightly narrowed near base which is almost symmetric, with stalks 2–10 mm long; upper pinnae sessile and often more asymmetric at base. *Largest sterile pinnae* to 20 × 4 cm, acuminate, lobed about half-way to costa, lobes falcate; costules 6–10 mm apart; veins to 10 on acroscopic side, to 14 on basicopic, basal veins from adjacent groups almost parallel for some distance below the sinus, basicopic veins arising from the costa far from their costules and sometimes anastomosing with the veins next above them; *lower surface* of rachis and costae short-hairy, many small scales also present on costae, sparse short hairs and rudimentary scales on costules. *Fertile fronds* smaller than sterile; largest pinnae 12.5 × 2.5 cm, usually lobed a little more than half-way to costa; orange-red glands often present on lower surface of costules, minute scales consisting of 2–3 cells, the terminal one glandular, present on young fronds on and between veins. *Sori* medial, lower ones divergent, often somewhat elongate along veins; indusia very small, often hidden by sporangia, short-hairy.

*Distr.* Peninsular Thailand, in *Malesia*: Malaya, Sumatra, Borneo.

*Ecol.* In forest, at 0–1200 m.

*Notes.* The type of *Dryopteris vinosicarpa* V.A.V.R. was a small plant but fertile. In 1975 I associated with it some small plants from mid-mountain forest in Malaya, restricting the name *M. motleyanum* to larger lowland plants which were thinner in texture. But plants from Sarawak, now in cultivation at Kew, bridge the gap between the two forms. Some specimens may represent hybrids between this species and *M. crassifolium*, but in general the two species appear to be distinct.

**11. *Mesophlebion falcatilobum* HOLTUM, sp. nov.**

*Frondes dimorphae*; pinnae usque 18-jugatae, inferiores stipitatae, steriles usque 14 × 2.5 cm, fertiles usque 11.5 × 1.7 cm, omnes dimidio costam versus lobatae, lobis falcatis; venae infimae 2–3 mm infra sinum conniventes; indusia minuta,

*glabra, sporangii fere obiecta.* — Type: JERMY 13694, Sarawak, G. Mulu (BM).

KEY TO THE VARIETIES

1. Sterile pinna-lobes with obtuse to rounded apices . . . . . **a. var. falcatilobum**
1. Sterile pinna-lobes with apiculate apices . . . . . **b. var. apiculatum**

**a. var. falcatilobum**

*Caudex* short-creeping; *stipe* 45 cm long, glabrous, scales short, not persistent, glabrous, sometimes with red glands on margin near apex. *Lamina* 45–50 cm long (sterile and fertile about equal); pinnae c. 18 pairs, several lower pairs with stalks, stalks of lowest 5–6 mm, somewhat narrowed towards base; aerophores swollen on living fronds, collapsing on drying. *Sterile pinnae* to 14 × 2.5 cm; apex evenly attenuate, apical 2.5 cm entire; edges lobed half-way to costa or a little less deeply, lobes falcate with obtuse to rounded forward-pointing apices; costules 7 mm apart; veins to 11 on basicopic side, 8 on acroscopic, basal basicopic vein arising from costa far from its costule, basal veins from adjacent lobes converging to touch the sinus-membrane 2–3 mm below the sinus; *lower surface* of rachis and costae bearing a variable number of short hairs, many narrow scales on costae and a few glands; hairs on *upper surface* of rachis and costae pale, thin, 0.3 mm long, rather sparse. *Sori* a little supramedial, lower ones divergent; indusia very small, glabrous; spores winged. *Chromosomes*: 2n = 72 (T. G. WALKER, plant from type collection cult. Kew).

*Distr. Malesia*: Borneo (Sarawak: Mt Mulu); besides type, several other plants in cultivation which are smaller than the wild plant but otherwise similar.

**b. var. apiculatum** HOLTUM, var. nov., a *typo speciei differt*: pinnis sterilibus usque 9 × 1.6 cm, 1/3 costam versus lobatis, lobis valde apiculatis. — Type: JERMY 13611, G. Mulu, Sarawak, in forest at 100–180 m (BM).

Pinnae c. 14 pairs, sterile to 9 × 1.6 cm, fertile to 6.5 × 1.0 cm, lobed less than half-way to costa; lobes of sterile pinnae very oblique with acute tips; lobes of fertile pinnae crenulate; sori all inframedial; lower surfaces of pinnae quite glabrous.

*Distr. Malesia*: Borneo (Sarawak: Mt Mulu), only known from the type.

**12. *Mesophlebion dulitense* HOLTUM, Blumea 22 (1975) 229.** — Type: C. HOSE s.n. 1894, Mt Dulit, Sarawak. (K; P).

*Caudex* not seen; *stipe* more than 75 cm long, glabrescent with dull reddish flush, basal scales

15 mm or more long, thin, narrow. *Lamina* incomplete, probably more than 75 cm long, texture very firm. *Largest pinnae* probably 30–40 cm long, 6.5 cm wide, with stalks 3–5 cm long; base very asymmetric with one basal lobe almost free and separated from the rest; edges lobed to 3 mm from costa; lobes slightly falcate, slightly narrowed distally; costules 10 mm apart, almost at right angles to costa; veins to 25 pairs, rather thick and prominent on both sides, basal basiscopic vein arising near base of its costule in basal part of pinna, remote from costule in distal part; *lower surface* of rachis and costae sparsely short-hairy, when young with many scales to 2 mm long. *Sori* inframedial distally on lobes, basal ones divergent; indusia very small, caducous, bearing 1–2 short hairs.

Distr. *Malesia*: Borneo. Known from type locality, and G. Mulu, and Mt Kinabalu (2 collections).

Note. The Kinabalu plants, from 1500 m, are smaller than the type (pinnae to 20 × 5 cm, with stalk to 3.5 cm long) but agree in scales, hairs and indusia.

**13. *Mesophlebion auriculiferum*** (v.A.v.R.) HOLTUM, *Blumea* 22 (1975) 231. — *Dryopteris auriculifera* v.A.v.R. Bull. Jard. Bot. Btzg III, 5 (1922) 197. — *Thelypteris auriculifera* (v.A.v.R.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 253. — Type: BÜNNEMEIJER 6905, Lingga Is., Mt Tanda (BO; L).

*Caudex* short; *stipe* 50–60 cm long, when young densely hairy, basal scales rigid, to 7 × 1 mm. *Lamina* 50 cm long; pinnae 17–20 pairs, all stalked, mostly not opposite; basal pinnae with stalks to 7 mm long, basal acroscopic lobe short and often free, basal basiscopic lobe attached further from rachis than acroscopic; texture firm, brittle when dry. *Largest pinnae* 15 × 2 cm; base cuneate with reduced lowest lobes, apex acuminate with cauda to 2 cm long; edges lobed to 2 mm from costa, lobes falcate; costules 4–4.5 mm apart; veins 10–11 pairs, basal acroscopic vein passing to side of short sinus-membrane, basal basiscopic vein to edge just above base of sinus; *lower surface* of costae bearing many spreading pale hairs to 1 mm long, similar hairs more sparse on costules and veins, no scales seen; surface between veins bearing many short slender erect hairs and sessile glands. *Sori* inframedial; indusia thin, pale, with many short capitate and acicular hairs, also a few glands like those on surface between veins; a small glandular cell at end of short hair on stalk of sporangium; spores not seen.

Distr. *Malesia*: N.E. Sumatra (Lingga Is.). Known from type collection only, in forest at 600 m.

Note. The pubescence of the lower surface of this plant most nearly resembles that of *M. teuscheri* and *M. arenicola*; the latter are much

smaller plants, growing apparently in a different kind of habitat.

**14. *Mesophlebion beccarianum*** (CESATI) HOLTUM, *Blumea* 22 (1975) 230. — *Nephrodium beccarianum* CESATI, Atti Acad. Napoli 7, n. 8 (1876) 23. — *Dryopteris beccariana* (CESATI) C. CHR. Ind. Fil. (1905) 254; v.A.v.R. Handb. (1908) 185; C. CHR. Gard. Bull. Str. Settl. 4 (1929) 384. — *Thelypteris beccariana* (CESATI) REED, *Phytologia* 17 (1968) 263. — Type: BECCARI s.n., Sarawak (FI).

*Dryopteris pallescens* BRAUSE, Bot. Jahrb. 56 (1920) 88. — *Thelypteris pallescens* (BRAUSE) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 253. — *Mesophlebion pallescens* (BRAUSE) HOLTUM, *Blumea* 22 (1975) 230. — Type: LEDERMANN 9146, N.E. New Guinea, Sepik Distr. (B; BM). — Fig. 6f-g.

*Caudex* short- to long-creeping, to 8 mm diameter; *stipe* to 50 cm or more long, glabrescent, basal scales firm, to 7 mm long, 1 mm or more wide at base with filiform apex. *Lamina* to 50 cm long, firm, usually drying greenish; pinnae 20 pairs or more, often almost opposite, basal pinnae with stalks 5–10 mm long, basal pair of lobes often much reduced, basal acroscopic lobe sometimes almost free. *Largest pinnae* 12–18 cm long, 1.6–2.5 cm wide (sterile often wider than fertile); base broadly cuneate to subtruncate; apex acuminate with cauda 2–2.5 cm long; edges lobed to 1–1.5 mm from costa, lobes oblique and slightly falcate, tips rounded or broadly pointed; costules 3.5–4.5 mm apart; veins 10–12(–15) pairs, basal basiscopic vein arising from costa near base of its costule, often ending just above base of sinus; *lower surface* of rachis hairless or nearly so, of costae often with sparse hairs 0.2 mm long, costal scales 1–2 mm long, very narrow with a few marginal hairs, early caducous. *Sori* inframedial; indusia large, firm, purplish, glabrous; spores minutely papillose.

Distr. *Malesia*: Southern Malaya, Sarawak, West and East New Guinea.

Ecol. In forest on sloping ground or ridges at 200–1200 m.

Note. The type of *Dryopteris pallescens* has rather numerous short hairs on costae; in other respects it differs little from the type of *M. beccarianum*. A specimen from Western New Guinea is almost glabrous. Some specimens from Malaya are intermediate between this and *M. chlamydophorum*, having hairs on the lower surface of costae and on indusia; Sarawak specimens seen are very uniform, and the species seems locally abundant there.

**15. *Mesophlebion rufescens*** HOLTUM, *Blumea* 22 (1975) 230. — Type: BRASS 27957, Sudest Island (K; BO, L, LAE).

*Caudex* "stout, horizontal" (BRASS); *stipe* 50–

80 cm long, lightly flushed with red, basal scales rigid, dark, 4×1 mm, distal part of stipe short-hairy. *Lamina* 42 cm long, texture firm, red-brown when dry; pinnae 12 pairs, mostly opposite; basal pinnae with stalks 10 mm long, basal pair of lobes much reduced; fourth pair of pinnae truncate to full width at base. *Largest pinnae* 12×2.8 cm; apex with cauda 1 cm long; edges lobed to 2.5–3 mm from costa, lobes slightly falcate with obtuse to rounded tips; costules 5 mm apart (fertile), 6 mm (sterile); veins 12–14 pairs, pale and prominent both sides, basal basisopic vein arising from costa near base of its costule, usually ending just above base of sinus; *lower surface* of rachis and costae bearing copious slender pale hairs 0.3 mm long and many narrow scales, on costules and veins sparse hairs, smaller narrow scales and large red glands, short erect hairs on surface between veins. *Sori* medial, lower ones divergent; indusia very small, glabrous, early caducous; glands on stalk of sporangia very large.

Distr. *Malesia*: Philippines (Biliran: SULIT PNH 20240; Luzon: Sierra Madre, JACOBS 7625) and New Guinea (Sudest I. and Geelvink Bay, SCHÖNIAN s.n. 1929 in B).

Ecol. In forest at 300 m.

**16. *Mesophlebion chlamydophorum*** (C. CHR.) HOLTUM, *Blumea* 22 (1975) 321. — *Dryopteris chlamydophora* ROSENST. *Med. Rijksherb. n.* 31 (1917) 5, *nom. nud.*; C. CHR. *Gard. Bull. Str. Settl.* 4 (1929) 384. — *Thelypteris chlamydophora* (C. CHR.) CHING, *Bull. Fan Mem. Inst. Biol. Bot.* 6 (1936) 287; HOLTUM, *Rev. Fl. Malaya* 2 (1955) 246, f. 139. — *Mesoneuron chlamydophorum* (C. CHR.) CHING, *Acta Phytotax. Sinica* 8 (1963) 325. — Lectotype (HOLTUM 1975): KORTHALS s.n. Borneo (L, sheet n. 908, 342–57).

*Lastrea nephrodioides* BEDD. *Ferns Brit. Ind.* (1866) t. 199, *non* MOORE 1858; BEDD. *Handb.* (1883) 238. — Type: PARISH, Burma (K, fragment only).

*Caudex* short to rather long-creeping, diameter commonly 5 mm; *stipe* to 60 cm or more long, basal scales 3–4 mm long. *Fronds* of mature plant usually all fertile, with lamina to 80 cm long, drying brown-olivaceous; pinnae 15–20 pairs, lower pinnae with stalks 2–3 mm or sometimes longer, 1–3 pairs of basal lobes reduced. *Largest pinnae* commonly 15×2 cm, to 20×2.5 cm; apex acuminate; edges lobed to 2–3 mm from costa, lobes falcate; costules 4–5.5 mm apart; veins commonly 10–12 pairs, basal pair of veins passing to either side of sinus-membrane, basal basisopic vein arising nearer to its costule than in *M. crassifolium* (variable); *lower surface* of rachis, costae and costules bearing very short hairs and narrow scales, rudimentary scales (some consisting of 2–3 cells with glandular end-cell) on all parts of lower surface, shrivelling and caducous with age. *Sori* not very close to costules, basal ones divergent;

indusia fairly large, firm, bearing a variable number of very short acicular hairs; spores papillose.

Distr. S. Burma and Peninsular Thailand, in *Malesia*: Malaya, Sumatra, Borneo, Celebes, ? New Guinea.

Ecol. In lowland forest, especially freshwater swamp-forest.

Note. ROSENSTOCK published no description and cited "*Aspidium crassifolium* METT. (*non* BL.)", but METTENIUS also published no description. The type selected is a specimen named by ROSENSTOCK.

**17. *Mesophlebion crassifolium*** (BL.) HOLTUM, *Blumea* 22 (1975) 232. — *Aspidium crassifolium* BL. *En. Pl. Jav.* (1828) 158; RACIB. *Fl. Btzig I* (1898) 169. — *Lastrea crassifolia* (BL.) MOORE, *Ind. Fil.* (1858) 89; COPEL. *Fern Fl. Philip.* (1960) 325. — *Dryopteris crassifolia* (BL.) O. KTZE, *Rev. Gen. Pl.* 2 (1891) 812; v.A.v.R. *Handb.* (1908) 182, *excl. var. motleyana*; C. CHR. *Gard. Bull. Str. Settl.* 4 (1929) 385; *ibid.* 7 (1934) 242, *incl. var. purpureo-lilacina*; BACKER & POSTH. *Varenfl. Java* (1939) 39. — *Thelypteris crassifolia* (BL.) CHING, *Bull. Fan Mem. Inst. Biol. Bot.* 6 (1936) 285; HOLTUM, *Rev. Fl. Malaya* 2 (1955) 246. — *Mesoneuron crassifolium* (BL.) CHING, *Acta Phytotax. Sinica* 8 (1963) 325. — Type: BLUME, *Java* (L, sheet n. 908, 342–64).

*Aspidium latum* KUNZE ex METT. *Farngett. IV* (1858) 95. — Type: CUMING 266, Luzon (B; BM, G, K).

*Dryopteris divergens* ROSENST. in *Fedde Repert.* 13 (1914) 218. — *Thelypteris divergens* (ROSENST.) REED, *Phytologia* 17 (1968) 273. — Type: J. WINKLER 36a, 1910, Sumatra (not seen).

*Dryopteris subdimorpha* COPEL. *Univ. Cal. Publ. Bot.* 18 (1942) 220. — *Lastrea subdimorpha* (COPEL.) COPEL. *Gen. Fil.* (1947) 140; Philip. J. Sci. 78 (1951) 432, pl. 20. — *Thelypteris subdimorpha* (COPEL.) REED, *Phytologia* 17 (1968) 317. — Type: BRASS 13666, Idenburg River, New Guinea (MICH). — **Fig. 1k.**

*Caudex* creeping, diameter to 8 mm or more; *stipe* to 80 cm or more long on fertile fronds, on sterile shorter, basal scales rigid, to 10 mm or more long, with cordate base to 1.5 mm wide. *Lamina* to 70 cm long, ± dimorphous, texture very firm; pinnae to 20 pairs, subopposite, rather widely spaced; basal pinnae with stalks 3–15 mm long, basal 1–3 pairs of lobes reduced. *Largest fertile pinnae* 15×3 cm (sterile to 25×4.5 cm), apex acuminate and sometimes caudate; edges lobed to 3–4(–5) mm from costa, lobes falcate; costules 4–6 mm apart (to 8 mm in largest sterile pinnae), at a wide angle to costa; veins 12–15 pairs, pale and prominent both sides, basal veins from adjacent costules curved upwards so that their distal parts are close together on either side of the sinus-membrane, basal basisopic vein usually arising far from its costule; *lower surface*

of rachis and costae copiously short-hairy, bearing also narrow brown scales and sometimes glands on costules. Sori inframedial, lower ones somewhat divergent; indusia usually rather large but thin, shrivelling when dried, bearing short hairs, less commonly quite small.

Distr. Malesia, except Java and Lesser Sunda Islands.

Ecol. In forest on hill slopes at 700–1800 m.

Notes. This species is variable as regards development of large sterile fronds and as

regards length of stalks of lower pinnae. Some specimens appear to be intermediate between typical *M. crassifolium* and *M. molleyanum* or *M. beccarianum*; one from Malaya has spores with perispore intermediate between the winged type normal in this species and the papillose spores of *M. beccarianum*. Most specimens from Malaya and Borneo have rather large but thin indusia, but a few have quite small indusia; specimens from the Philippines (Luzon, Negros, Leyte) have all quite small indusia.

### 10. CYCLOSORUS

LINK, Hort. Reg. Bot. Berol. 2 (1833) 128; HOLTUM, SEN & MITTRA, Blumea 18 (1970) 200, 212; HOLTUM, Blumea 19 (1971) 27; Allertonia 1 (1977) 181; of most other authors *p.p. min.* — Fig. 1r, 7a–c.

Caudex long-creeping; scales proportionally broad, their hairs almost all marginal; lowest pinnae not reduced; all pinnae lobed; basal veins always anastomosing with a long excurrent vein to the sinus; lower surfaces

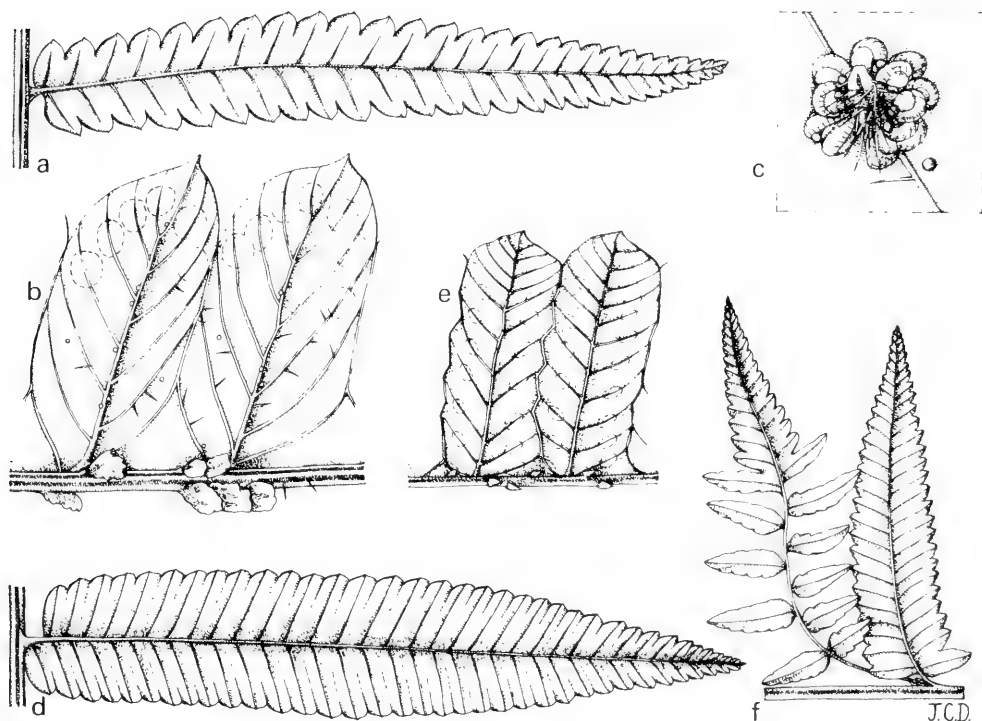


Fig. 7. *Cyclosorus interruptus* (WILLD.) H. ITO. a. Basal pinna,  $\times 1.5$ ; b. part of pinna showing scales, hairs, glands and position of sori,  $\times 8$ ; c. sorus, showing glands among sporangia,  $\times 32$ . — *Ampelopteris prolifera* (RETZ.) COPEL. d. One primary pinna,  $\times 1$ ; e. two pinna-lobes showing venation, scales and position of sori,  $\times 3$ ; f. first frond of a young plant proliferating from axil of primary pinna,  $\times \frac{1}{3}$  (a–c T. LOBB 19, d–f MATTHEW s.n.)

variously hairy, broad flat scales always present on costae, rather large red spherical glands on costules and veins; sori indusiate; no glands nor hairs on body of sporangia, long hairs with terminal red glands on sporangium-stalks; spores closely and irregularly spinulose.

Type species: *Cyclosorus gongylodes* (SCHKUHR) LINK.

Distr. Pantropic; probably 3 species.

Ecol. Always in freshwater swamps or edges of lakes, in full sun or light shade.

Cytol. All Indian and African records diploid, with  $n = 36$ ; in the W. Indies and S. America some plants tetraploid.

Taxon. In his monograph of *Dryopteris* (1913) CHRISTENSEN adopted the name *Cyclosorus* with subgeneric status for a group of tropical American species, most of which are not closely related to *C. gongylodes* (of which the type specimen came from Guiana). CHING extended the use of the name, with generic rank, to cover species of the Old World some of which are related to the atypical American species of CHRISTENSEN. COPELAND (Gen. Fil. 1947) followed CHING, distinguishing *Cyclosorus* from *Lastrea* (= *Thelypteris sensu* CHING) solely by anastomosing/free venation, but this does not result in a natural division. In my judgement, *Cyclosorus* (as here restricted) is most nearly related to *Ampelopteris* (see HOLTUM, SEN & MITRA 1970) and *Thelypteris s. str.* (all have the same aquatic habitat and a wide distribution), probably also to *Mesophlebion*, not closely to any other group. As here restricted, *Cyclosorus* is a complex which can only be resolved by extensive cytotaxonomic study of plants from the whole of its range. The fronds of W. Indian tetraploids are large, firm and almost hairless on the lower surface; South African plants, originally named *Polypodium tottum* THUNB., have a similar aspect. Seventeen binomials, with different types, are based on specimens belonging to this complex.

1. *Cyclosorus interruptus* (WILLD.) H. ITO, Bot. Mag. Tokyo 51 (1937) 714, *nomen tantum*; HOLTUM, J. S. Afr. Bot. 40 (1974) 152. — *Pteris interrupta* WILLD. Phytographia (1794) 13, t. 10 f. 1; HOLTUM, Amer. Fern J. 63 (1973) 81. — *Thelypteris interrupta* (WILLD.) K. IWATS. J. Jap. Bot. 38 (1963) 314, *nomen tantum*; FOSBERG & SACHET, Smiths. Contr. Bot. 8 (1972) 8. — Type: KLEIN, S. India (B; Herb. Willd. 19, 770).

*Aspidium obtusatum* Sw. in Schrad. J. Bot. 1800, 2 (1801) 33; Syn. Fil. (1806) 248; WILLD. Spec. Pl. 5 (1810) 241. — Type: THUNBERG, Java (BM, fragment).

*Nephrodium propinquum* R. BR. Prodr. Fl. N. Holl. (1810) 148; BEDD. Ferns S. India (1863) t. 89. — Type: BANKS, Queensland (BM; not seen).

*Aspidium venulosum* BL. En. Pl. Jav. (1828) 151. — Type: Java (not seen).

*Hypopeltis marginifera* BORY in Bél. Voy. Ind. Or. Bot. 2 (1833) 69. — Type: BÉLANGER, Java (not seen).

*Hypopeltis propinquoidea* BORY, *ibid.* l.c. — Type: BÉLANGER, Java (not seen).

*Polypodium unitum* LINN. Syst. Nat. ed. 10, 2 (1759) 1326 *quoad* Burm. Zeyl. *tantum*. — *Aspidium unitum sensu* SCHKUHR, Krypt. Gew. (1804) 34, t. 33b; *sensu* SW. Syn. Fil. (1806) 47; *sensu* BL. En. Pl. Jav. (1828) 150; *sensu* METT. Ann. Mus. Bot. Lugd.-Bat. 1 (1864) 230, *var. hirsutum tantum*. — *Nephrodium unitum sensu* R. BR. Prodr. Fl. N. Holl. (1810) 148; *sensu* BEDD. Handb. (1883) 268; *sensu* RACIB. Fl. Btzig I (1898) 182.

*Dryopteris gongylodes sensu* v.A.v.R. Handb. (1908) 212; *sensu* BACKER & POSTH. Varenfl.

Java (1939) 57. — *C. gongylodes sensu* CHING, Bull. Fan Mem. Inst. Biol. Bot. 8 (1938) 186; *sensu* HOLTUM, Rev. Fl. Malaya 2 (1955) 261, f. 148; *sensu* COPEL. Fern Fl. Philip. (1960) 360. (All doubtfully based on *Aspidium gongylodes* SCHKUHR, Krypt. Gew. (1809) 193, t. 33c). — Fig. 1r, 7a-c.

Stipe to c. 45 cm long, lightly flushed with red above dark base, glabrescent. Lamina commonly 30–50 cm long; pinnae 20–25 pairs; several pairs lower pinnae slightly narrowed towards an asymmetric base. Largest pinnae commonly 10–15 cm long, 1.0–1.8 cm wide, in shaded places sometimes larger, texture firm; apex short-acuminate; edges lobed less than half-way to costa, lobes oblique, broadly rounded with distinct cartilaginous edges and a small apiculus; costules commonly 3.5–4.5 mm apart, at less than 60° to costa; veins 8–10 pairs or more, very oblique except basal pair, 1–1½ pairs anastomosing and usually 1 pair touching sides of the short sinus-membrane; lower surface of rachis, costae, costules and veins bearing a variable number of short erect pale acicular and sometimes capitate hairs, a few hairs also sometimes on surface between veins, a variable number of large red glands scattered on costules and veins, broad thin flat fringed scales on costae; upper surface of rachis covered with short hairs, few short hairs on costae and edges. Sori supramedial except on distal veins, absent from basal pair of veins; indusia thin, bearing short acicular hairs and sometimes capitate hairs.

Distr. Tropics and subtropics.

Notes. It seems probable that *Aspidium*

*gongyloides* SCHKUHR was a tetraploid; his specimens at B and his illustration agree with known tetraploids. But some other tropical American specimens are not clearly distinct from the plants of Asia and Africa known to be diploid. The morphological distinctions of the tetraploid need to be established, and the type of *Pteris polypodioides* POIR. (1804), an earlier name, needs to be examined; also *P. tottum* THUNB. (1800) from South Africa must be taken into consideration. In any case, the name *gongyloides* is incorrect for the Malesian plants.

WILLDENOW's type was misconstrued by

CHING, who identified it with the species here named *Amphineuron terminans* (HOOK.) HOLTUM, and his identification was copied by many subsequent authors. In 1801 SWARTZ published the name *Aspidium obtusatum* with *Pteris interrupta* WILLD. as a synonym; this identification was accepted by WILLDENOW in 1810.

The nature and distribution of hairs on the lower surfaces of pinnae of Malesian plants varies greatly. Specimens with many short capitate hairs have been collected in Sabah and Sarawak, also in Mainland Asia from Peninsular Thailand to Assam and also Hainan.

## 11. AMPELOPTERIS

KUNZE, Bot. Zeit. 6 (1848) 114; COPEL. Gen. Fil. (1947) 143; CHING, Acta Phytotax. Sinica 8 (1963) 330; HOLTUM, SEN & MITTRA, Blumea 18 (1970) 196, 214; HOLTUM, Blumea 19 (1971) 25. — *Meniscium* sect. *Ampelopteris* K. IWATS. Mem. Coll. Sci. Univ. Kyoto B, 31 (1964) 39. — *Thelypteris* subg. *Meniscium* sect. *Ampelopteris* REED, Phytologia 17 (1968) 255. — Fig. 7d-f.

Caudex creeping; fronds of indefinite apical growth, bearing many buds at the bases of primary pinnae, the buds developing into new plants; forked or branched unicellular acicular hairs present on rachis; sori exindusiate; stalks of sporangia bearing hairs each terminating in a large globular gland; spores similar to those of *Cyclosorus*.

Type species: *Ampelopteris elegans* KUNZE = *A. prolifera* (RETZ.) COPEL.

Distr. Monotypic. Old World tropics.

Cytol. Chromosome number 36 (India & Ceylon), several records (all diploid).

Notes. This genus resembles *Cyclosorus* in sporangia, spores and in ovate scales on lower surface of costae; the two genera also agree in creeping rhizome and aquatic habitat. *Ampelopteris* is the only Old World member of the family which has branched acicular hairs; in this character it resembles *Goniopteris*, a genus of many species in the New World.

**1. *Ampelopteris prolifera* (RETZ.) COPEL.** Gen. Fil. (1947) 144; HOLTUM, Rev. Fl. Malaya 2 (1955) 299; COPEL. Fern Fl. Philip. (1960) 377. — *Hemionitis prolifera* RETZ. Obs. Bot. 6 (1791) 38. — *Meniscium proliferum* (RETZ.) SW. Syn. Fil. (1806) 19, 207; HOOK. 2nd Cent. Ferns (1861) t. 15, f. 1-3, *tantum*. — *Goniopteris prolifera* (RETZ.) PRESL, Tent. Pterid. (1836) 183; BEDD. Ferns S. India (1864) t. 172; Handb. (1883) 296, f. 153. — *Polypodium luxurians* KUNZE, Linnaea 23 (1850) 28, *nom. nov.* — *Phegopteris luxurians* (KUNZE) METT. Farngatt. IV (1858) 25. — *Phegopteris prolifera* (RETZ.) KUHN in v. Decken Reise (1879) 44; v.A.v.R. Handb. (1908) 504. — *Dryopteris prolifera* (RETZ.) C. CHR. Ind. Fil. (1905) 286; BACKER & POSTH. Varenfl. Java (1939) 55. — *Cyclosorus proliferus* (RETZ.) TARD. & C. CHR. Notul. Syst. 14 (1952) 346. — *Thelypteris prolifera* (RETZ.) REED, Phytologia 17

(1968) 306. — Type: KOENIG, S. India (GOET).

*A. elegans* KUNZE, Bot. Zeit. 6 (1848) 114. — Type: ZOLLINGER 2360, Java (isotypes at BM, G, P, W).

*Goniopteris meniscioides* FÉE, Gen. Fil. (1852) 253. — Type: CUMING 168 (P; FI-W, G, K, LE). — Fig. 7d-f.

Primary pinnae to 20 × 2 cm, often with a short stalk; base truncate to subcordate; apex rather evenly attenuate; edges lobed to a depth of 2 mm; costules 3-4 mm apart; veins 10-12 pairs, 5-6 pairs anastomosing to form a zig-zag excurrent vein; lower surfaces hairless, costae bearing ovate ciliate scales. Sori exindusiate, somewhat elongate, on distal parts of veins. Fronds on plants formed by proliferation from buds much smaller, usually with pinna-like terminal lamina; pinnae sometimes fertile from a size of 3.5 × 0.8 cm.

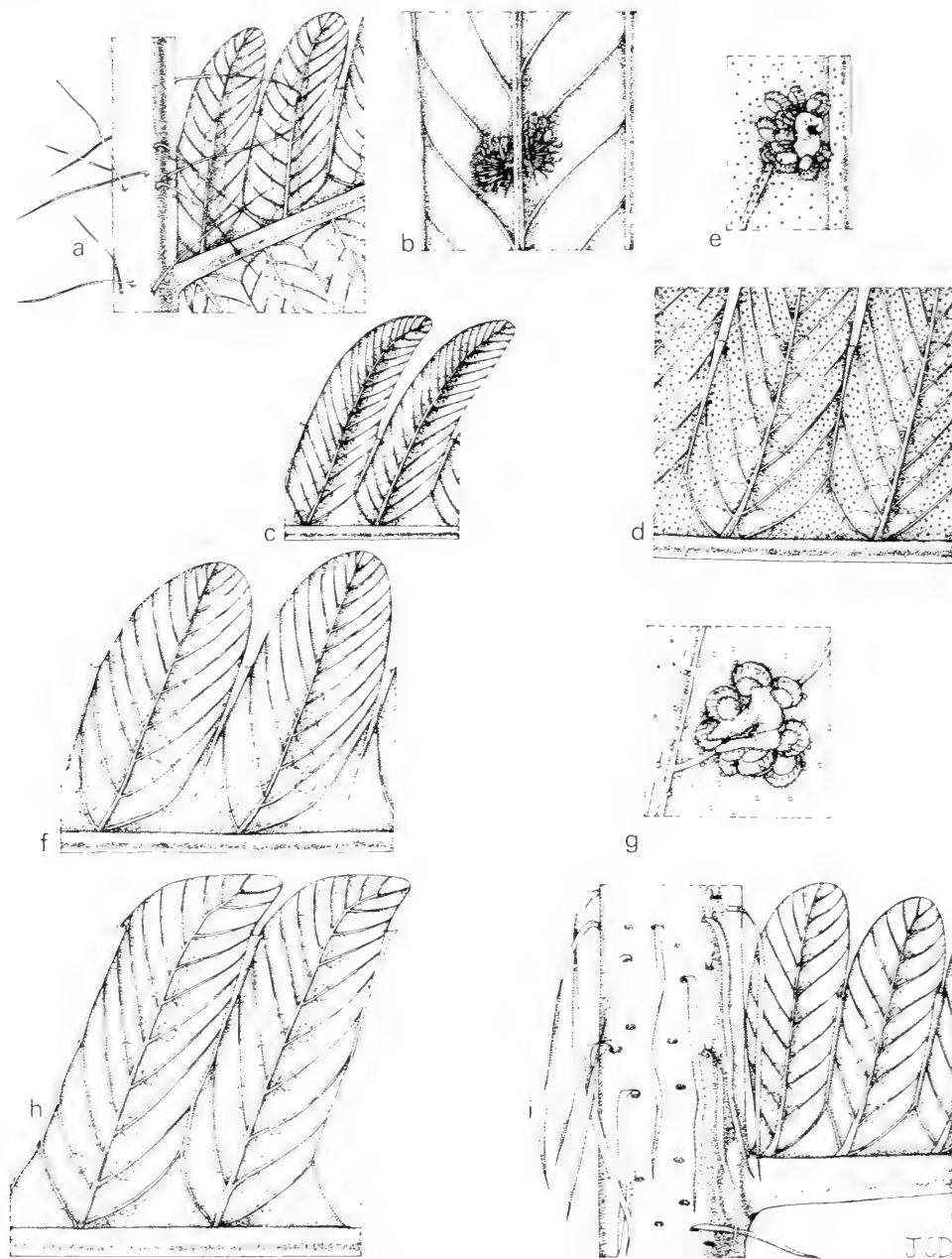


Fig. 8. *Chingia ferox* (BL.) HOLTUM. a. Rachis with terete scales and base of a pinna bearing coalescent sori,  $\times 4$ ; b. two old sori,  $\times 12$ . — *C. sakayensis* (ZEILLER) HOLTUM. c. Two pinna-lobes,  $\times 2$ ; d. part of a pinna showing glands and position of sori,  $\times 4$ ; e. one sorus,  $\times 10$ . — *C. pricei* HOLTUM. f. Two pinna-lobes, showing venation and position of sori,  $\times 4$ ; g. one sorus,  $\times 16$ . — *C. christii* (COPEL.) HOLTUM. h. Two pinna-lobes,  $\times 4$ . — *C. clavipilosa* HOLTUM var. *javanica* HOLTUM. i. Rachis with flat scales and base of a pinna,  $\times 4$  (a-b MOUSSET s.n., c-e DAY s.n., f-g PRICE 512, h ELMER 10187, i CLEMENS 30514).



Distr. West Africa to N.E. Australia (to 30°S) and New Caledonia; widely in tropical mainland Asia; throughout *Malesia* but not often collected.

Ecol. On banks of rivers and ditches, sometimes forming thickets.

Notes No distinct varieties have been observed. The unnumbered figure of a complete small plant on HOOKER's plate (1861) represents *Pronephrium hosei* (BAK.) HOLTUM.

12. CHINGIA

HOLTUM, *Blumea* 19 (1971) 31; *Kalikasan* 3 (1974) 13–28. — Fig. 8.

Caudex massive, erect, sometimes forming a trunk 30–100 cm tall. Fronds usually rather rigid in texture, commonly 150–250 cm long including stipe, axes usually drying red-brown; basal pinnae not reduced; aerophores not enlarged; at least the base of the stipe, in many cases the whole of it and part or all of the rachis persistently scaly, scales at base of stipe narrow, often rigid, setiferous, in some species grading into quite terete spine-like scales above base of stipe. Pinnae crenate to deeply lobed, in most species to 30 cm or more long; veins numerous, all except the basal pair very oblique, basal 1–3 pairs anastomosing (except in *C. pricei*), the next 1–3 or more pairs passing to sides of a long sinus-membrane; some acicular hairs often present on lower surfaces, sometimes only on young plants or those growing in exposed places; capitate glandular hairs or small sessile glands abundant in some species on lower or both surfaces of pinnae. Sori near costules except the lowest 1–2 pairs which may be divergent; indusia small or lacking; young sporangia in some species bearing small sessile glands or capitate hairs, in one species rarely setae; spores dark, covered with minute papillae or wings.

Type species: *Chingia ferox* (BL.) HOLTUM.

Distr. *Malesia* and the Pacific (to Tahiti); in Mainland Asia only to Peninsular Thailand; in all 20 species.

Ecol. Usually on hill slopes in moderately exposed places, at 300–2000 m, sometimes locally abundant (used for thatching in Mindoro).

Cytol. Chromosome number 36 (*C. atrospinosa*, *C. urens*, both diploid).

Notes. This very natural group appears to be closely related to *Plesioneuron* but not to any other genus of the present arrangement. CHING and COPELAND placed the species known to them in *Cyclosorus* without distinguishing them as a natural group. The nature and distribution of scales are distinctive in the various species, and some early collections do not show these characters adequately. New information has recently been added by the collections of M. G. PRICE in the Philippines where seven species occur. Chemical investigation might yield interesting results; two species are recorded as malodorous, and one (*C. urens*) as causing a mild burning sensation in contact with human skin.

Plants of *Glaephyropteridopsis* CHING (type species *G. erubescens* (HOOK.) CHING, distributed from N.E. India to S. China) are similar to *Chingia* in frond-form, but the veins are always free, aerophores swollen, and the spores and scales are very different; the two are probably not very nearly related.

KEY TO THE SPECIES

1. Abaxial surface of rachis bearing slender terete spine-like scales.
2. Pinnae crenate to a depth of 1 mm . . . . . 1. *C. acutidens*
2. Pinnae much more deeply lobed.
3. Pinnae 8–12 pairs, 6 cm or more apart . . . . . 2. *C. atrospinosa*
3. Pinnae to 20 or more pairs, closer together.
4. Sori all elongate; veins not prominent on lower surface . . . . . 3. *C. muricata*
4. At most basal sori elongate; veins rather thick and prominent beneath.

5. Pinnæ not over 3 cm wide, lobed 1/4-2/5; basal sori only divergent but not elongate . . . . . 4. *C. ferox*  
 5. Pinnæ to 3.5 cm or more wide, lobed 2/5-3/5; basal 2-3 pairs of sori divergent and lowest elongate . . . . . 5. *C. imponens*
1. Abaxial surface of rachis in most species lacking scales; scales, if present in this position, distinctly flat.  
 6. Basal veins not meeting but passing to sides of the sinus-membrane which is decurrent below their junction with it . . . . . 6. *C. pricei*  
 6. Basal veins anastomosing or at least meeting below base of sinus-membrane which is not decurrent.  
 7. Stipe scaly throughout; at least lower part of rachis scaly on abaxial side.  
 8. Pinnæ to 3 cm wide, thin, drying light greenish; small indusia present . . . . . 7. *C. sakayensis*  
 8. Pinnæ not over 2.5 cm wide, firm, drying brown-olivaceous; no indusia . . . . . 8. *C. clavipilosa*  
 9. Capitate hairs abundant on lower surface of costae and costules; capitate hairs and sessile glands between veins . . . . . 8a. *C. clavipilosa* var. *clavipilosa*  
 9. Glands mainly sessile, lacking between veins . . . . . 8b. *C. clavipilosa* var. *javanica*  
 7. Stipe scaly near base only; rachis not scaly on abaxial surface.  
 10. Rachis bearing slender terete scales on adaxial surface . . . . . 9. *C. bewaniensis*  
 10. Rachis lacking scales on adaxial surface, or such scales flat.  
 11. Pinnæ crenate to a depth of 1.5-3 mm; no indusia.  
 12. Lower surfaces covered with slender erect acicular hairs . . . . . 10. *C. lorzingii*  
 12. Lower surfaces glabrous.  
 13. Pinnæ thin; veins not prominent beneath; sori close to costules except lowest . . . . . 11. *C. sambasensis*  
 13. Pinnæ firm; veins prominent beneath; several pairs of lower sori gradually divergent . . . . . 12. *C. christii*
11. Pinnæ lobed 1/3 towards costa or more deeply; indusia present in most cases.  
 14. Lower surface bearing sessile glands . . . . . 13. *C. paucipaleata*  
 14. Lower surface bearing acicular and/or capitate hairs.  
 15. Lower surface densely acicular-hairy throughout, lacking capitate hairs; no capitate hairs on sporangia . . . . . 14. *C. horridipes*  
 15. Lower surface bearing short capitate hairs at least on costules and veins; capitate hairs (rarely setae) present on sporangia.  
 16. Pinnæ thick and rigid; veins prominent on lower surface, grooved on upper surface . . . . . 15. *C. perrigida*  
 16. Pinnæ thin; veins not prominent on lower surface nor grooved on upper surface.  
 17. Basal pair of veins anastomosing to form a slender excurrent vein which is joined by the second acroscopic vein before entering base of sinus-membrane . . . . . 16. *C. supraspinigera*  
 17. Basal pair of veins meeting, or not quite meeting, at base of sinus-membrane.  
 18. Pinnæ lobed less than half-way to costa; sori indusiate . . . . . 17. *C. urens*  
 18. Pinnæ lobed more than half-way to costa; sori exindusiate . . . . . 18. *C. tenerior*

1. *Chingia acutidens* HOLTUM, Kalikasan 3 (1974) 17.—Type: ALSTON 15708, Mt Manimporok, Soputan Mts, Minahassa, Celebes (BM).

Stipe more than 85 cm long, rather copiously black-muricate throughout (bases of former scales), abaxial surface of rachis similarly but less prominently muricate. *Lamina* 170 cm long, apex pinna-like; pinnæ nearly 40 pairs; basal pinnæ narrowed to base on basiscopic side, acroscopic base truncate and slightly auricled. *Suprabasal pinnæ* to 42 × 2.4 cm; base broadly cuneate; apex acuminate with slender cauda to 6 cm long; edges crenate-serrate to a depth of 1 mm; costules 4.5-5 mm apart, at more than 60°; veins to 10 pairs, 2 pairs anastomosing, 3 or more pairs passing to sides of sinus-membrane; lower surface of pinnæ glabrous apart from sparse hairs on sinus-membrane and edge; upper surface with short hairs on costae only. Sori rather large, distinctly free from costules, at least basal ones elongate; no indusia; no glands on sporangia.

Distr. *Malesia*: N. Celebes (type and POST-HUMUS 2566).

2. *Chingia atrospinosa* (C. CHR.) HOLTUM, Kalikasan 3 (1974) 19.—*Dryopteris atrospinosa* C. CHR. Bot. Jahrb. 66 (1933) 43.—*Thelypteris atrospinosa* (C. CHR.) REED, Phytologia 17 (1968) 261.—Type: KJELLBERG 3652, Rante Lemo, Celebes (S-PA; BO).

Stipe to 75 cm long, stramineous; basal scales 10 mm long, hardly 1 mm wide, dark brown, glossy, with short spreading hairs; above base throughout bearing many short black spines (bases of former scales); lower surface of rachis bearing also scattered spines or terete dark scales. *Lamina* to 75 cm long, apex almost pinna-like; pinnæ 8-12 pairs, widely spaced, rigid; basal pinnæ narrowed gradually to their bases, with stalks 2-3 mm long. *Suprabasal pinnæ* 25-30 cm long, 2.5-3.0 cm wide; base broadly cuneate; apex acuminate with sharp-toothed cauda 3 cm or more long; edges

lobed 1/3 towards costa, lobes falcate, narrowed to acute tip; costules 5 mm apart; veins 10–11 pairs, slightly prominent both sides, 2 pairs anastomosing, 2 pairs to sides of sinus-membrane; lower surface of costae and costules bearing stiff spreading slender hairs 0.5–1 mm long, scattered hairs on and between veins; upper surface hairy on costa and edges only. *Sori* near costules, exindusiate, spreading a little along veins; no glands on sporangia.

Distr. *Malesia*: Celebes (N to SW); Sabah.

Ecol. At 1000–2000 m, in open places, in some cases near streams.

**3. *Chingia muricata* (BRAUSE) HOLTUM**, *Kalikasan* 3 (1974) 20. — *Dryopteris muricata* BRAUSE, *Bot. Jahrb.* 56 (1920) 106, excl. *var. marginata* et *var. obscura*. — *Cyclosorus imponens sensu* COPEL. *Philip. J. Sci.* 78 (1951) 457, p.p. — *Thelypteris muricata* (BRAUSE) REED, *Phytologia* 17 (1968) 295. — Type: LEDERMANN 12720, Sepik Distr., New Guinea (B).

*Stipe* 45 cm long, densely covered with spines 1–2 mm long and scales; scales to  $24 \times 1$  mm, hair-pointed, bearing short setae, grading in distal part of stipe to terete hairy spines 8 mm long. *Lamina* c. 100 cm long; pinnae closely spaced; basal pinnae somewhat narrowed to their bases and short-stalked; texture coriaceous. *Largest pinnae* of type  $35 \times 3.3$  cm; base subtruncate, apex acuminate, not caudate; edges lobed 1/3–2/5 towards costa, lobes close, falcate; costules to 5.5 mm apart; veins 10–12 pairs, grooved on upper surface, hardly evident on lower when dry,  $1\frac{1}{2}$  pairs anastomosing, 2 pairs to sides of sinus-membrane; lower surface of rachis with slender terete bristles to 8 mm long, of pinnae glabrous apart from a few hairs on sinus-membrane and edges. *Sori* all somewhat elongate (elliptic in outline), distal ones near costule, lower ones a little divergent, exindusiate; no glands on sporangia.

Distr. *Malesia*: New Guinea, from Idenburg River to Morobe District.

Ecol. Type from wet rocky place; others from secondary forest, at 850–1500 m.

**4. *Chingia ferox* (BL.) HOLTUM**, *Blumea* 19 (1971) 31; *Kalikasan* 3 (1974) 21. — *Aspidium ferox* BL. *En. Pl. Jav.* (1828) 153. — *Nephrodium ferox* (BL.) MOORE, *Ind. Fil.* (1858) 91; HOOK. *Spec. Fil.* 4 (1862) 77, excl. Wallich, Kamaon; RACIB. *Fl. Btzig I* (1898) 192. — *Phegopteris ferox* (BL.) METT. *Ann. Mus. Bot. Lugd.-Bat.* 1 (1864) 224. — *Dryopteris ferox* (BL.) O. KTZE, *Rev. Gen. Pl.* 2 (1891) 812; v.A.v.R. *Handb.* (1908) 221, 819, excl. *var. calvescens*; BACKER & POSTH. *Varenfl. Java* (1939) 62. — *Cyclosorus ferox* (BL.) CHING, *Bull. Fan Mem. Inst. Biol. Bot.* 8 (1938) 167; COPEL. *Fern Fl. Philip.* (1960) 347. — *Thelypteris ferox* (BL.) TAGAWA & K. IWATS. *Acta Phytotax. Geobot.* 23 (1968) 54. — Type: BLUME,

West Java (L, sheet n. 908, 331–305).

*Polypodium scabrum* ROXB. *Calc. J. Nat. Hist.* 4 (1844) 491. — Type: WALLICH *Cat.* 2225, Amboina (isotype K; ill. as *Nephrodium ferox* by BEDD. *Ferns Br. India* t. 129).

*Goniopteris barbata* FÉE, *Gen. Fil.* (1852) 252. — *Phegopteris barbata* (FÉE) METT. *Farngett.* IV (1858) 24. — *Polypodium barbatum* (FÉE) HOOK. *Spec. Fil.* 5 (1864) 10. — Type: CUMING 172, Luzon (orig.?; isotypes BM, K, L, SING). — Fig. 8a–b.

*Caudex* to 20 cm or more tall; *stipe* commonly 100 cm long, largest basal scales  $25 \times 1.5$  mm, thin, glossy, setiferous, medium brown; scales on upper part of stipe and on rachis terete or nearly so, hairless, dark, 5–10 mm long, often broken leaving warts or short spines. *Lamina* 100–200 cm long, texture varying with altitude and exposure; basal pinnae slightly narrowed at their bases which are slightly auricled on acroscopic side. *Largest pinnae* 18–40(–50) cm long, 1.6–3.0 cm wide, narrowly acuminate; edges lobed 1/4–2/5 towards costa; lobes with acute falcate tips; costules 3.5–4.5 mm apart; veins to 16 pairs, not very thick, variably prominent on lower surface, grooved or flat on upper, 1 pair anastomosing, 3–4 pairs passing to sides of sinus-membrane; lower surface of costae, costules, sinus-membranes and edges bearing  $\pm$  abundant erect slender acicular hairs, sometimes also capitate hairs (which may be abundant on sterile pinnae) on costules and veins. *Sori* exindusiate, close to costules except basal basispic one, not elongate; sporangia of Java specimens lacking glands, small red glands present on some specimens from Moluccas and Philippines.

Distr. *Malesia*: Java, Lesser Sunda Islands, Borneo, Celebes, Philippines, Moluccas, New Guinea.

Ecol. Usually in secondary growth, on hill-slopes; 500–2000 m.

Notes. The specimen n. 2225 from Herb. Wallich among HOOKER's specimens at Kew is labelled Kamaon in HOOKER's hand, though ROXBURGH gave Amboina as its origin; another was figured by BEDDOME; both have small red glands on the sporangia like those from the Moluccas. No locality is indicated in Wallich's Catalogue. Philippine specimens seen are more shallowly lobed than those from Java.

**5. *Chingia imponens* (CES.) HOLTUM**, *Kalikasan* 3 (1974) 21. — *Polypodium imponens* CES. *Rendic. Acad. Napoli* 16 (1877) 27, 29. — *Dryopteris imponens* (CES.) C. CHR. *Ind. Fil.* (1905) 271; *Dansk Bot. Ark.* 9, 3 (1937) 50, pl. V, f. 5. — *Phegopteris imponens* (CES.) v.A.v.R. *Handb.* (1908) 506. — *Cyclosorus imponens* (CES.) COPEL. *Gen. Fil.* (1947) 142; *Philip. J. Sci.* 78 (1951) 437. — *Thelypteris imponens* (CES.) REED, *Phytologia* 17 (1968) 284. — Type: BECCARI, Arfak Mts, W. New

Guinea (FI, Herb. Becc. 12668).

*Dryopteris armata* ROSENST. Hedwigia 56 (1915) 351. — *Phegopteris armata* (ROSENST.) v.A.v.R. Handb. Suppl. (1917) 318. — Type: BAMLER 111, Sattelberg, N.E. New Guinea (B; UC).

*Dryopteris muricata* var. *marginata* BRAUSE, Bot. Jahrb. 56 (1920) 107. — Type: LEDERMANN 11937, Sepik Distr., New Guinea (B).

*D. muricata* var. *obscura* BRAUSE, l.c. 108. — Type: LEDERMANN 12022, same locality.

*Stipe* 100 cm or more long; basal scales 15–20 × 1.5 mm, medium dull brown, rest of stipe and rachis bearing many slender terete dark scales to 10 mm long, often broken and reduced to short spines which bear a few stiff hairs. *Lamina* 150 cm or more long; pinnae close, many pairs; lowest pinnae gradually narrowed in basal 8–10 cm, with stalks 2 mm long. *Largest pinnae* commonly 45 × 3.5–4.0 cm; base subtruncate; apex gradually attenuate; edges lobed 2/5–3/5 towards costa, lobes falcate distally; costules 6–6.5 mm apart; veins 12–15 pairs, slender, dark beneath and slightly prominent, grooved on upper surface when dry, 1 pair anastomosing, 2–3 pairs passing to sinus-membrane; lower surface of costae, costules, veins and sinus-membranes bearing sparse short pale acicular hairs; upper surface of costae bearing slender pale to brownish hairs 0.5 mm or more long, few hairs on costules. *Sori* near costules except basal 2 pairs which are divergent and slightly elongate; no indusia; no glands on sporangia.

Distr. *Malesia*: Eastern New Guinea, at altitudes to 1800 m, many collections.

Note. This species is very near *C. ferox* but has less rigid and more deeply-lobed pinnae and stiff hairs on the stumps of broken terete scales on the rachis.

6. *Chingia pricei* HOLTUM, Kalikasan 3 (1974) 22. — Type: M. G. PRICE 512, Mt Santo Tomas, Benguet Prov. Luzon, exposed place near summit (PNH; K). — Fig. 8f–g.

*Caudex* 10 cm diameter (collector); stipe 45–60 cm long, basal half covered with glossy light brown scales to 10 × 1 mm, thin but firm, thickened at base, bearing sparse stiff hairs; distal part of stipe, and rachis, bearing only smaller scales (which are not terete) on edges of groove of adaxial surface, abaxial surface smooth. *Lamina* to 60 cm long; pinnae more than 20 pairs; lowest pinnae hardly narrowed near base, basal acroscopic lobe elongate; texture firm. *Largest fertile pinnae* 13 cm long, 2.1 cm wide above base (sterile to 18 × 2.3 cm); base truncate, usually dilated both sides to a total width of 3 cm; apex acuminate; edges lobed half-way to costa or a little more deeply, lobes slightly falcate; costules 4–4.5 mm apart; veins 10 pairs, basal pair very oblique, not joining but passing to sides of the sinus-membrane which is decurrent between them, next 1½–2 pairs

also passing to sides of the membrane; lower surface of rachis, costae, costules, veins and between veins bearing copious short capitate hairs, acicular hairs present on sinus-membranes and edges; upper surface of costae covered with many thick brownish hairs less than 0.5 mm long, sparse acicular hairs on costules, scattered short capitate hairs on and between veins. Distal *sori* close to costules, lower ones a little divergent; indusia fairly large, thin, shrivelling, with capitate and acicular hairs; capitate hairs on sporangia.

Distr. *Malesia*: Philippines (Luzon), known from type only.

7. *Chingia sakayensis* (ZEILLER) HOLTUM, *comb. nov.* — *Nephrodium sakayense* ZEILLER, Bull. Soc. Bot. France 32 (1885) 75; BEDD. Handb. Suppl. (1892) 78. — *Thelypteris sakayensis* (ZEILLER) REED, Phytologia 17 (1968) 311. — *Sphaerostephanos sakayensis* (ZEILLER) HOLTUM in Nayar & Kaur, Comp. to Bedd. (1974) 209. — Type: DE MORGAN s.n. 6 Aug. 1884, near Gunong Riam, Perak, 750 m (P; K).

*C. pseudoferox* HOLTUM, Kalikasan 3 (1974) 24. — Type: MATTHEW s.n. 6 Feb. 1908, G. Hijau, Perak (K).

*Cyclosorus ferox sensu* HOLTUM, Rev. Fl. Malaya 2 (1955) 265, f. 151, *quoad pl. Malay. tantum*. — Fig. 8c–e.

*Stipe* to 200 cm long, densely scaly throughout; scales to 20 × 1.5 mm, rigid, flat with thickened persistent bases, dark brown, bearing short stiff marginal and superficial setae; abaxial surface of basal part of rachis bearing very narrow and shorter similar scales. *Lamina* to 200 cm long; pinnae many pairs, texture thinner than in *C. ferox*, drying light greenish; basal pinnae gradually much narrowed towards their bases which may be only 5 mm wide. *Largest pinnae* to 40 × 3 cm (type of *C. pseudoferox*) but in young plants sometimes fertile at 19 × 1.6 cm (type of *N. sakayense*); apex rather evenly narrow-attenuate; edges lobed about half-way to costa, lobes distally falcate and narrowed to an obtuse tip; costules 5 mm apart; veins 10–15 pairs, slender and slightly prominent on lower surface, 1–2 pairs anastomosing, next 2–3 pairs to sides of sinus-membrane; lower surface of costae, costules, veins and surface between veins bearing ± abundant small sessile yellowish glands, short acicular hairs also sometimes present; upper surface hairy on costae and costules only, no glands. *Sori* close to costules except basal ones which are often a little elongate; indusia very small, bearing a few small glands; sporangia with small glands.

Distr. Peninsular Thailand, in *Malesia*: Malaya, Sumatra, Sarawak, W. Java.

Ecol. In forest, often near streams, at 150–1200 m.

Note. The type of *N. sakayense* at Paris consists of the apical part of a frond; at Kew are 2

detached pinnae. The aspect of these specimens is so different from that of fully grown plants that formerly I failed to recognize their identity, which is confirmed by recent gatherings of other small fertile plants. The single specimen from W. Java is from G. Pulosari at 600 m (ADELBERG 492).

**8. *Chingia clavipilosa* HOLTUM**, *Kalikasan* 3 (1974) 23. — Type: HOLTUM 44, Mt Kinabalu 2300 m, Sabah (K).

**a. var. *clavipilosa***

*Stipe* densely scaly throughout, scales all flat, basal ones  $15 \times 1$  mm; scales on abaxial surface of *rachis* more sparse but present throughout, very narrow but distinctly flat, not terete, at their bases. *Basal pinnae* narrowed towards base which is 1.5 cm wide. *Largest pinnae*  $28 \times 2.5$  cm, very firm, lobed  $1/3$  towards costa; costules 4.5 mm apart; veins to 12 pairs, slender and slightly prominent on lower surface, not on upper,  $1-1\frac{1}{2}$  pairs anastomosing, 2–3 pairs passing to sides of sinus-membrane; *lower surface* of costae (at least distally) and costules bearing  $\pm$  abundant slender spreading hairs to 1.5 mm long; on costae, costules and veins abundant small capitate hairs, on surface between veins short capitate hairs and very small sessile glands; *upper surface* of costae bearing thick brownish hairs 0.7 mm long, rest glabrous. *Sori* close to costules except on basal veins; no indusia; sporangia bearing capitate hairs.

Distr. *Malesia*: N. Borneo (Kinabalu) and Philippines (Luzon, Mountain Province).

Note. The description is prepared from Kinabalu specimens; those from N. Luzon are much smaller (pinnae to  $10 \times 1$  cm) with more copious acicular hairs on lower surface.

**b. var. *javanica* HOLTUM, var. nov., ab var. *clavipilosa* differt: costis costulis venisque subulis glandulis sessilibus vel subsessilibus praeditis, glandulis inter venas nullis; sporangiis immaturis glandulis pallidis minutis praeditis.** — Type: 1221 Herb. Bog., Tjibeureum, G. Gedeh, Java (BO). — Fig. 8i.

Distr. *Malesia*: West Java, many specimens, 1800–2000 m; Sarawak, G. Mulu.

Note. These specimens were formerly included in *C. ferox* but differ in the distinctly flat scales on the abaxial surface of the rachis and in the small glands on young sporangia.

**9. *Chingia bewaniensis* HOLTUM, sp. nov.**

*Stipes basin versus tantum paleatus, paleis omnibus applanatis; pagina adaxialis rhachidis paleis teretibus praedita, pagina abaxialis minute verrucosa; cetera C. feroci similis.* — Type: JERMY 8170, Bewani Mts, N.E. New Guinea, 300 m (BM).

*Stipe* 70 cm long, densely scaly at base only, above base minutely verrucose; scales 15 mm

long, 0.5–1.0 mm wide, thin, medium brown, bearing sparse setae. *Lamina* firm, drying light olivaceous, 120 cm long; several pairs lower pinnae gradually narrowed towards their bases which are 1.1 cm wide with auricle to 9 mm long on acroscopic side, stalk 2 mm. *Largest pinnae*  $45 \times 2.5$  cm; apex narrowly acuminate; edges lobed  $1/3$  towards costa, lobes falcate subacute; costules 5 mm apart; veins to 12 pairs on acroscopic side, 14 on basiscopic, 1 pair anastomosing, 2–3 pairs passing to sides of sinus-membrane; *lower surface* of rachis pale, glabrous, with minute warts as upper part of stipe, of costae glabrous; *upper surface* of rachis, within the groove, bearing many slender terete scales, costae copiously antrorse-hairy, rest glabrous. *Sori* near costules, basal ones only slightly divergent, exindusiate; sporangia bearing small red glands.

Distr. *Malesia*: Papua New Guinea; only known from the type.

**10. *Chingia lorzingii* HOLTUM, sp. nov.**

*Stipes basin versus tantum paleatus; pagina abaxialis rhachidis pilis acicularibus patentibus 0.7–0.8 mm longis dense vestita; pinnae tenues, maximae  $20 \times 1.8$  cm, vix  $1/4$  costam versus lobatae, subulis omnino pilis acicularibus erectis vestitae; sori exindusiati; sporangia glandulis non praedita.* — Type: LÖRZING 16188, Karoplateau, Dolok-baros, Sumatra, 1750–1950 m (BO).

*Stipe* 80 cm long; basal scales few, flat; upper part of stipe bearing short pale acicular hairs and very few scales; abaxial surface of rachis, especially distally, densely covered with pale erect acicular hairs 0.7–0.8 mm long. *Lamina* 80 cm long; pinnae c. 30 pairs, texture thin but firm; basal pinnae narrowed very gradually towards their bases. *Largest pinnae*  $20 \times 1.8$  cm; base broadly cuneate; apex narrowly acuminate; edges lobed to a depth of 2 mm (hardly  $1/4$  towards costa); costules 4–5 mm apart, at less than  $60^\circ$ ; veins 8–9 pairs, slender, hardly prominent either side,  $1-1\frac{1}{2}$  pairs anastomosing, 3 pairs to sides of sinus-membrane; all parts of *lower surface* bearing erect slender acicular hairs c. 0.7 mm long, most densely on costae, very short capitate hairs also present on and between veins; *upper surface* of costae bearing thicker hairs, shorter ones also on costules and veins. *Sori* all close to costules, not elongate, exindusiate; no glands on sporangia.

Distr. *Malesia*: N.E. Sumatra; known from the type and SURBECK 814, from Sibuan.

**11. *Chingia sambasensis* HOLTUM, *Kalikasan* 3 (1974) 24. — *Dryopteris penangiana* var. *calvescens* sensu COPEL. Philip. J. Sci. 5 (1910) Bot. 283 quoad pl. Brooks. tantum.** — Type: C. J. BROOKS s.n. Sept. 1908, Sambas, W. Kalimantan, 900 m (BM; K, L, MICH).

*Stipe* of type lacking (see also below); rachis red-brown, quite smooth on abaxial surface. *Lar-*

gest pinnae 43×3.3 cm, thin, drying light olivaceous; apex narrowly attenuate; edges crenate to a depth of 2–2.5 mm; costules 5 mm apart; veins slender, slightly prominent on upper surface, not on lower, 10–11 pairs, 1–1½ pairs anastomosing, 4 pairs to sides of sinus-membrane; lower surface of pinnae quite glabrous; upper surface glabrous except for a few hairs near base of costae. Sori close to costules except basal basiscopic one, all slightly elongate, exindusiate; no glands on sporangia.

Distr. *Malesia*: Borneo. Besides the type, an unlocalized Bornean specimen of KORTHALS.

Note. The Korthals specimens (3 sheets at B, 2 at L) include a stipe of 125 cm, rather sparsely scaly near base, scales flat, narrow, long-acuminate, on rest of stipe scattered small black warts and a few narrow dark flat scales. One sheet bears the apex of a frond which is not fully expanded; it shows some short capitate hairs on both surfaces and on sporangia. The largest pinna is 24×2.1 cm, in shape and venation like the type.

**12. *Chingia christii* (COPEL.) HOLTUM**, *Kalikasan* 3 (1974) 25. — *Dryopteris ferox* var. *calvescens* CHRIST, *Philip. J. Sci.* 2 (1907) Bot. 193. — *Cyclosorus christii* COPEL. *Fern Fl. Philip.* (1960) 362 excl. ESCRITOR BS 20707. — *Thelypteris zamboangana* REED, *Phytologia* 17 (1968) 325, nom. nov. (not *T. christii* (C. CHR.) REED). — Type: COPELAND 1721, San Ramon, Mindanao, 800 m (MICH; B, NSW). — Fig. 8h.

Stipe to 200 cm long (ELMER), castaneous, scaly at base only; scales 15×0.5 mm, thick, dull brown; upper part of stipe, and rachis, smooth on abaxial surface. *Lamina* 100 cm or more long; basal pinnae narrowed at asymmetric base, with stalks 2 mm long. *Largest pinnae* of type 25–35 cm long, 2.0–2.7 cm wide (but see note below), very firm, drying red-brown; apex long-attenuate with subentire cauda 3 cm long; edges crenately lobed to a depth of 2–3 mm, lobes falcate, acute; costules 4.5–5.5 mm apart; veins to 10 pairs, prominent on lower surface, 1½ pairs anastomosing, 3 pairs to sides of sinus-membrane; lower surface of type quite glabrous, of ELMER 10182 bearing a few small capitate hairs and sessile glands on costules and veins; upper surface hairy on costa only. Lower sori gradually divergent from costule, several pairs somewhat elongate; no indusia; sporangia bearing small glands.

Distr. *Malesia*: Philippines (Mindanao, Negros, Mindoro).

Note. With ELMER 10182 (from Negros) in UC is a note by the collector that the frond was 4 m long, with largest pinnae 52×3.3 cm.

**13. *Chingia paucipaleata* HOLTUM**, *Kalikasan* 3 (1974) 26. — Type: M. G. PRICE 781, Tignoan, Infanta, Quezon Prov., Luzon (PNH; K).

Stipe to 150 cm long, basal 15 cm covered with

scales, rest glossy, castaneous, sparsely verrucose; scales to 20 mm long, little more than 0.5 mm wide, thin, contorted when dry, bearing few setae. *Lamina* to 100 cm long; pinnae to at least 30 pairs, subopposite, 3.5 cm apart; several lower pairs slightly narrowed at their bases, sessile. *Largest pinnae* 24×1.5 cm; base subtruncate; apex narrowly attenuate; edges lobed 2/5 towards costa (to a depth of 3 mm), lobes falcate at tips; costules 3.5 mm apart; veins to 9 pairs, slender, distinct but hardly prominent on lower surface, 1–1½ pairs anastomosing, 1 pair to sides of sinus-membrane; lower surface of costae and costules glabrescent (some acicular hairs distally on young fronds), on veins and surface between them rather abundant small sessile glands; on upper surface of rachis sparse warts representing bases of scales, hairs on costae pale, 0.8 mm long. Sori all near costules, not elongate; indusia small, with a few small glands or short hairs.

Distr. *Malesia*: Philippines (Luzon).

Note. ESCRITOR BS 20707, from Tayabas Province, Luzon, (in Herb. Kew.) agrees with the above description but has pinnae to 32×2 cm and smaller indusia.

**14. *Chingia horridipes* (v.A.v.R.) HOLTUM**, *Kalikasan* 3 (1974) 26. — *Dryopteris horridipes* v.A.v.R. *Bull. Jard. Bot. Btzig II*, 28 (1918) 23. — *Thelypteris horridipes* (v.A.v.R.) REED, *Phytologia* 17 (1968) 283. — Type: BÜNNEMEIJER 9684, Mt Talamau, Sumatra (BO).

Scales at base of stipe to at least 10×1.5 mm, short-hairy throughout; above base of stipe scattered small warts (bases of former scales), uppermost part of stipe, and rachis, with sparse warts on adaxial surface only. *Lamina* 100 cm or more long, texture subcoriaceous; lowest pinnae narrowed towards their bases. *Largest pinnae* 35×2.2 cm; base truncate; apex acuminate; edges lobed almost half-way to costa; costules to 5 mm apart; veins to 15 pairs, grooved on upper surface, 1–1½ pairs anastomosing, 1½–2 pairs passing to sides of sinus-membrane; lower surface of costae and costules densely covered throughout with acicular hairs to nearly 1 mm long, fewer hairs on and between veins; upper surface hairy on costae and costules only. Sori near costules; indusia minute, short-hairy; sporangia lacking glands.

Distr. *Malesia*: Central West Sumatra (Mts Talamau and Kerintji), at 2200–2750 m.

**15. *Chingia perrigida* (v.A.v.R.) HOLTUM**, *Kalikasan* 3 (1974) 27. — *Phegopteris perrigida* v.A.v.R. *Bull. Jard. Bot. Btzig II*, 16 (1914) 27; *Handb. Suppl.* (1917) 317. — Type: MATTHEW 513, Mt Merapi, Sumatra (BO).

*Dryopteris ferox* var. *calvescens* sensu v.A.v.R. *Bull. Jard. Bot. Btzig III*, 2 (1920) 150, *quoad Koorders* 43567 tantum.

Stipe to 100 cm long, densely scaly near base

only; basal scales to at least  $15 \times 1.5$  mm, stiff, flat at base, apex very slender; no scales on abaxial surface of rachis. *Lamina* to 120 cm long; pinnae to at least 28 pairs; basal pinnae narrowed in basal 3 cm, basal lobes somewhat elongate. *Largest pinnae*  $30 \times 2.3$  cm; base truncate or broadly cuneate; apex evenly attenuate; edges lobed 1/3 towards costa or a little more deeply; costules 4.5–5 mm apart; veins 8–12 pairs, grooved on upper surface and prominent on lower, basal pair meeting at base of sinus-membrane, next 2 pairs to sides of the membrane; *lower surface* bearing short capitate hairs on all parts and a varied number of acicular hairs (sometimes none) on costules and veins. *Sori* near costules, basal ones not divergent; indusia very small, bearing short capitate hairs; many short capitate hairs on sporangia.

Distr. *Malesia*: Central Sumatra, central Malaya, East Java, Lesser Sunda Is. (Flores).

Ecol. In open places at 1500–2000 m.

Notes. Found in Malaya for the first time at Genting Highlands in 1977, beside a recently-made road at 1500 m. Specimens from the Tengger and Ijang mountains in East Java have fewer capitate hairs on the lower surface; they were wrongly named *Dryopteris ferox* var. *calvescens* by v.A.v.R. and one has the MS name *D. ferox* var. *mitis* ROSENST. KOORDERS 37503 (Tengger Mts) has a seta on a few sporangia, capitate hairs on others.

**16. *Chingia supraspinigera* (ROSENST.) HOLT-TUM**, *Kalikasan* 3 (1974) 27. — *Dryopteris supraspinigera* ROSENST. *Hedwigia* 56 (1915) 353. — *Cyclosorus supraspinigerus* (ROSENST.) COPEL. *Gen. Fil.* (1947) 143; Philip. J. Sci. 78 (1951) 447. — *Thelypteris supraspinigera* (ROSENST.) REED, *Phytologia* 17 (1968) 318. — Type: BAMLER 91, Sattelberg, N.E. New Guinea (S-PA; B, UC).

*Stipe* more than 40 cm long, scaly at base only; adaxial side of stipe above base, and of rachis, bearing scattered small scales (or their wart-like bases), abaxial side smooth. *Lamina* 75 cm or more long, rather thin; basal pinnae slightly narrowed close to their bases. *Largest pinnae*  $17 \times 1.8$  cm; base truncate; apex short-acuminate; edges lobed c. 1/3 towards costa; costules 4 mm apart; veins 8 pairs, very slender and hardly prominent either side, basal pair anastomosing to form a slender excurrent vein which is joined by the second acroscopic vein before entering the base of the sinus-membrane, next 2 pairs to sides of the membrane; *lower surface* of rachis and pinnae covered throughout with short thick hairs with variously thickened and sometimes wax-encrusted tips; *upper surface* of costae also bearing short papillae with a few acicular hairs. *Sori* all near costules; indusia small, glandular; sporangia bearing small glands.

Distr. *Malesia*: Papua New Guinea (Morobe Distr., 2 coll.).

Note. The second collection, from 300 m at foot of the Oomsis Range, is smaller than the type, with fertile pinnae  $12.5 \times 1.4$  cm, rather less deeply lobed.

**17. *Chingia urens* HOLTUM**, *Kalikasan* 3 (1974) 28. — Type: M. G. PRICE 2367, Mt Makiling, Batangas Prov. Luzon (PNH; K).

*Caudex* to 40 cm tall; *stipe* 75 cm long, basal 12 cm densely scaly, rest with sparse warts; basal scales to  $15 \times 1.5$  mm, rather thin, contorted when dry, dull brown, not hairy; *rachis* lacking warts on abaxial side which is densely covered with short capitate hairs. *Lamina* to 75 cm long, firm but rather thin; pinnae 25 pairs; basal pinnae gradually narrowed in basal 7 cm to a quite narrow base which is auricled, next 4 pairs of pinnae progressively wider at base. *Largest pinnae*  $29 \times 2.5$  cm; base broadly cuneate; apex narrowly attenuate; edges lobed almost half-way to costa, lobes falcate distally, acute, fringed with acicular hairs; costules 4–6 mm apart; veins 10–13 pairs, slender, not prominent either side, basal pair meeting, or not quite meeting, just below base of sinus-membrane, 2–3 pairs passing to sides of the membrane; *lower surface* bearing  $\pm$  abundant short capitate hairs throughout, a few acicular hairs on distal parts of costae only; *upper surface* of costae densely covered with thick acicular hairs to 1 mm long, sparse shorter acicular hairs on costules and veins, a few short acicular and capitate hairs between veins. *Sori* close to costules except basal ones, not elongate; indusia small but always distinct, thin, with short capitate and sometimes 1–2 acicular hairs; sporangia with capitate hairs.

Distr. *Malesia*: Philippines (Luzon), only known from type.

Ecol. On steep slope inside crater at 960 m.

Note. PRICE reports: "malodorous; skin contact with living fronds produces a mild burning sensation".

**18. *Chingia tenerior* HOLTUM, sp. nov.**

*Pinnae* usque  $30 \times 1.9$  cm, usque  $2/3$  costam versus lobatae, textura tenues; venae graciles, non prominentes, infimae vel ad basin membranae sinus junctae vel ibi conniventes non junctae, vena acroscopica secunda vel ad latus membranae vel ad marginem terminata; sori exindusiati; sporangia pilis capitatis praedita. — Type: RAMOS BS 33066, near Baguio, Ilocos Norte Prov. Luzon (P; US).

*Stipe* scaly at base only; scales thin, to 10 mm long, hardly 1 mm wide at base. *Pinnae* to  $30 \times 1.9$  cm, thin; apex gradually attenuate; edges lobed more than half-way (to  $2/3$ ) towards costa; costules 4 mm apart; veins to 15 pairs, very fine and not prominent either side, basal pair either meeting just below the sinus-membrane or touching the sides of the base of the membrane without meeting (base of membrane not decurrent be-

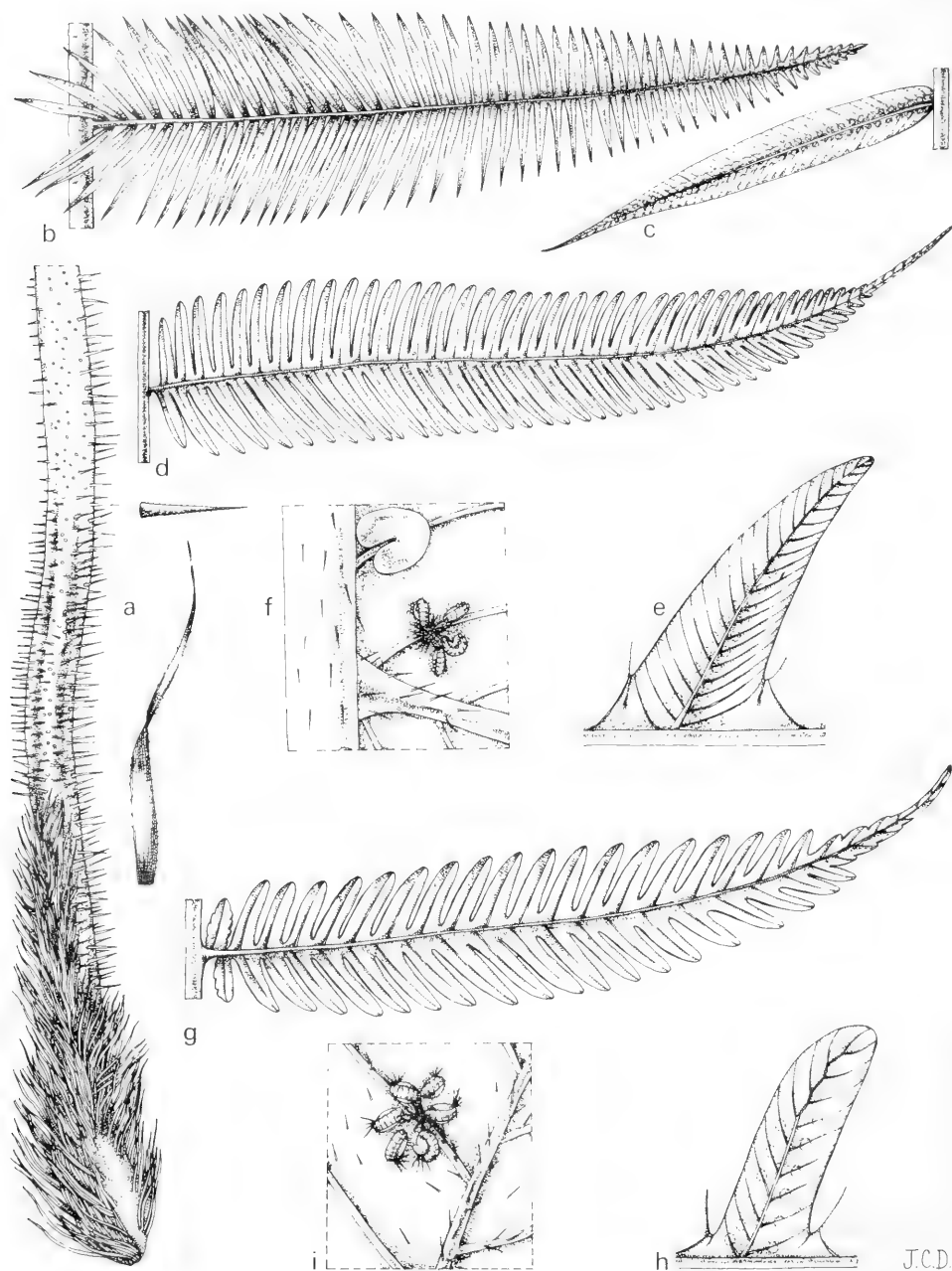


Fig. 9. *Plesioneuron marattioides* (ALSTON) HOLTUM. a. Base of stipe,  $\times \frac{2}{3}$ , with scale and spine,  $\times 2$ ; b. lower pinna,  $\times \frac{1}{2}$ ; c. one pinna-lobe,  $\times 1$ . — *P. tuberculatum* (CESATI) HOLTUM. d. Lower pinna,  $\times \frac{1}{2}$ ; e. one pinna-lobe,  $\times 3$ ; f. sori (one with indusium removed),  $\times 16$ . — *P. savaiense* (BAK.) HOLTUM. g. Basal pinna,  $\times 1$ ; h. one pinna-lobe,  $\times 3$ ; i. sorus,  $\times 16$  (a–c MILLAR & HOLTUM 15996, d FLOYD 5595, e–f BRASS 27112, g–i PRICE 2605).



tween them), second acroscopic vein ending at side of membrane or at margin just above base of sinus; *lower surface* throughout bearing scattered slender acicular hairs c. 0.4 mm long, short capitate hairs also present on veins and surface between them; *upper surface* of costae bearing rather sparse acicular hairs more than 0.5 mm

long, very few hairs on costules, no others. Sori near costules, exindusiate, not elongate; short capitate hairs on sporangia.

Distr. *Malesia*: Philippines (Luzon), only known from the type which was distributed as *Dryopteris extensa*.

### 13. PLESIONEURON

HOLTUM, *Blumea* 22 (1975) 232; *Allertonia* 1 (1977) 186; L. R. ATKINSON, *Phytomorphology* 25 (1975) 45 (gametophyte). — *Mesophlebion* subg. *Plesioneuron* HOLTUM, *Blumea* 19 (1971) 30. — Fig. 1j, 9.

Caudex erect or suberect, rarely prostrate. Stipe always scaly at base, sometimes throughout, bases of scales usually thickened, in some species spine-like and persistent; lowest pinnae not or little reduced, variously narrowed at their bases, sometimes with a free basal lobe (or more than one); pinnae of firm texture, deeply lobed, usually with somewhat swollen or elongate basal aerophores, lower surface often verrucose when dry; veins all free, tips of lowest from adjacent costules usually touching sides of a sinus-membrane which may be decurrent between them as a hairy ridge almost to the costa, in the most deeply lobed pinnae both basal veins passing to the margin above base of sinus; basal basiscopic vein arising from costa near its costule, or from base of the costule; unicellular acicular hairs on lower surface of costae and costules various, usually short and stiff, thick brown hairs also sometimes present, rarely short capitate hairs, reduced scales few on most species; short acicular or capitate hairs sometimes present between veins on upper surface. Sori usually medial or inframedial, in a few cases supramedial; indusium, when present, usually firm and dark; sporangia often bearing small red or yellow glands, or setae, near annulus; hairs on sporangium-stalk sometimes acicular, never bearing red glands; spores dark, spinulose, in most observed cases (winged in three species), in about 15 species not yet observed.

Type species: *Plesioneuron tuberculatum* (CESATI) HOLTUM.

Distr. *Malesia* & Pacific: Borneo (2 spp.); Moluccas (Tidore, Batjan, Buru, Amboina, 2 spp.); Mindanao (1 sp.); New Guinea & Bismarck Archipelago (32 spp.); islands of the Pacific, to Tahiti (12 spp.).

Ecol. In lowland and mid-mountain forest (and in a few cases to 2700 m) often by streams, sometimes pendulous from rock-crevices.

Cytol. Chromosome number 36 (*P. fulgens* only).

Taxon. The name *Plesioneuron* refers to the basal basiscopic veins in each pinna-lobe which always arise close to their costules, never far from them as in *Mesophlebion*. Plants of many species are similar in general aspect, and to some extent in venation, to *Mesophlebion*, to which genus they were assigned as a subgenus in 1971, but they differ from *Mesophlebion* in sporangia and spores, also, in a majority of species, in scales, and (in the only case investigated) in gametophytes. They appear to be related to *Chingia* and not very closely to any other genus. COPELAND included them in *Lastrea*, and published a key to the species of that genus in New Guinea (Philip. J. Sci. vol. 78, 1951) but he did not characterize them clearly nor distinguish them as a group. There are undoubtedly many species in New Guinea, but specimens of some are few or imperfect, so that more information about them is needed, and the present account probably needs some modification. Some type specimens may represent immature plants (an example is *P. ophiura*) and more local collecting is needed to establish this; in other cases small plants probably do represent the mature form of a species. Recent collections certainly include plants of previously undescribed species, and probably more remain to be discovered.

Several species show some degree of difference between lobes on acroscopic and basiscopic sides of a pinna, but there is no sharp distinction between these and those with no clear difference. However, in a few cases the difference is very marked and can be used in the key to the identification of species.

The sinus-membrane in *Plesioneuron* is in all cases distinctly decurrent from the base of the sinus as a more or less hairy ridge on the lower surface, sometimes almost reaching the costa. This condition is closely similar to that of *Dryopteris* subg. *Steiropteris* C. CHR. (Monogr. Dryopt. I, 1913, 161), a group of species in the American tropics. These species differ from *Plesioneuron* as follows: rhizome wide-creeping; septate hairs on lower surface of rachis and costae; neither glands nor setae on sporangia; spores with translucent wing and a few cross-wings (this type of spore occurs in a few species of *Plesioneuron*). Two aberrant species included with doubt by CHRISTENSEN in subg. *Steiropteris* are more similar to *Mesophlebion* and are mentioned under that genus.

I believe that characters of scales are often of diagnostic significance, but in many specimens they are not well represented; more information about them may help to clarify specific distinctions.

#### KEY TO THE SPECIES

1. Stipe and rachis bearing  $\pm$  copious dark spines (bases of former scales); sori in most cases exindusiate.
2. Pinnae not over 4.5 cm wide; costules not over 5 mm apart.
3. Pinnae to 4.5 cm long; pinna-lobes concave beneath; stipe-scales to 4 mm long . . . . . 1. *P. pullei*
3. Pinnae larger; pinna-lobes not concave beneath; stipe-scales 8 mm or more long.
4. Sori exindusiate.
5. Sporangia bearing several long setae . . . . . 2. *P. fuchsii*
5. Sporangia lacking setae.
6. Pinnae to  $9 \times 1.2$  cm; basal veins both passing to margin above base of sinus . . . . . 3. *P. medusella*
6. Pinnae of well-grown plants much larger; basal veins both ending beside sinus-membrane.
7. Stipe-scales terete at base and apex, less than 0.5 mm wide in middle; pinnae to 4.5 cm wide . . . . . 4. *P. woodlarkense*
7. Stipe-scales flat except at base, largest at least 1 mm wide; pinnae rarely more than 3 cm wide . . . . . 5. *P. dryopteroides*
4. Sori indusiate . . . . . 6. *P. varievestitum*
2. Largest pinnae 7–12 cm wide with costules 10–12 mm apart.
- 6a. All pinna-lobes or pinnules auricled at base on basiscopic side; veins forked or pinnate in the auricles . . . . . 7. *P. notabile*
- 6a. Pinna-lobes not thus auricled.
- 7a. Pinnae lobed almost to costae; lobes not separately adnate . . . . . 8. *P. septempedale*
- 7a. Pinna-lobes in basal half of pinnae separately adnate to costa . . . . . 9. *P. marattioides*
1. Stipe (except base) and rachis smooth; scales, if present, not spine-like; sori in almost all species indusiate.
8. Pinnae 1–5 pairs; apical lamina pinna-like; costules 5–7 mm apart . . . . . 10. *P. fulgens*
8. Pinnae commonly to at least 10 pairs, or if fewer costules 3–4 mm apart.
9. No indusia; no setae on sporangia.
10. Aerophores elongate; sori near costules . . . . . 11. *P. belense*
10. Aerophores not elongate; sori medial . . . . . 12. *P. wariense*
9. Indusia present, or if absent all sporangia setiferous.
11. Sporangia all setiferous; no glands present.
12. Sori supramedial; sporangia with 1–3 short setae . . . . . 13. *P. royenii*
12. Sori medial or inframedial; sporangia bearing several long setae.
13. Veins 10–12 pairs; largest pinnae not over  $12 \times 2.5$  cm, almost sessile . . . . . 14. *P. savaiese*
13. Veins 14–16 pairs; largest pinnae  $21 \times 3.3$  cm, with stalks 3–4 mm long . . . . . 15. *P. altum*
11. Sporangia usually with glands; setae, if present, short and not on all sporangia, sometimes alternating with glands.
14. Sori supramedial.
15. Pinnae to  $20 \times 3$  cm; veins 15–18 pairs.
16. Indusia overlapping margin; basal acroscopic lobe of lower pinnae elongate with forked veins . . . . . 16. *P. cystodioides*
16. Indusia not overlapping margin; basal acroscopic lobe of lower pinnae not enlarged . . . . . 17. *P. subterminale*
15. Pinnae smaller; veins not over 12 pairs.
17. Both basal lobes on basal pinnae free and short-stalked . . . . . 18. *P. bipinnatum*

17. Basal lobes of basal pinnae not free . . . . . 19. *P. quadriquetrum*
14. Sori medial or inframedial.
18. Pinna-lobes on both sides of costa conspicuously falcate.
19. Upper surface glabrous between veins; pinnae 8 pairs . . . . . 20. *P. falcatipinnulum*
19. Upper surface bearing hairs between veins; pinnae 20 pairs.
20. Hairs on lower surface of rachis and costae 1 mm long, on upper surface between veins appressed . . . . . 21. *P. kostermansii*
20. Hairs on lower surface of rachis and costae 0.3 mm long, on upper surface between veins short-erect . . . . . 22. *P. angiensis*
18. Pinna-lobes not conspicuously falcate on both sides of costa.
21. Basal 10–12 pairs of pinna-lobes separately adnate to costa . . . . . 23. *P. sandsii*
21. At most 1 free pinna-lobe separately adnate.
22. Pinnae to 25 × 5 cm, all except distal ones stalked; lower pinnae with stalks 3–6 mm; indusia small, caducous . . . . . 24. *P. tuberculatum*
22. Pinnae smaller; most pinnae almost sessile, basal ones with stalks at most 2–3 mm long; indusia firm, persistent.
23. Veins 20 pairs or more.
24. Basiscopic lobes of all pinnae strongly falcate and shorter than acroscopic lobes; basal scales to 20 mm long, very narrow . . . . . 25. *P. attenuatum*
24. Basiscopic lobes, if falcate, not or little shorter than acroscopic; basal scales much shorter, usually wider.
25. Basal acroscopic lobe of basal pinnae free, wider than the rest, with some forked veins . . . . . 26. *P. platylobum*
25. Basal acroscopic lobe of basal pinnae otherwise.
26. Lower surface quite glabrous.
27. Pinnae c. 11 × 2 cm; basal acroscopic lobe of basal pinnae reduced . . . . . 27. *P. crassum*
27. Pinnae c. 22 × 3 cm; basal acroscopic lobe of basal pinnae elongate . . . . . 28. *P. stenura*
26. Lower surface of costules at least bearing acicular hairs.
28. Pinnae lobed to 0.5 mm from costa . . . . . 29. *P. ophiura*
28. Pinnae lobed to 1–2 mm from costa . . . . . 30. *P. costulisorum*
23. Veins 10–15 pairs.
29. Basal pinnae with stalks 2 mm or more long.
30. Pinnae lobed to 1.5–2 mm from costa . . . . . 31. *P. doctersii*
30. Pinnae lobed to less than 1 mm from costa.
31. Basal scales thick, narrow; sori a little inframedial . . . . . 32. *P. rigidilobum*
31. Basal scales c. 5 × 1.5 mm; sori near costules . . . . . 29. *P. ophiura*
29. Basal pinnae sessile or nearly so.
32. Pinnae to 6 cm long; lobes on basiscopic side strongly falcate, on acroscopic side almost straight . . . . . 33. *P. wantontense*
32. Pinnae longer; lobes on basiscopic side not greatly different from those on acroscopic side.
33. Aerophores small, dark; sori medial or a little inframedial.
34. Some sporangia bearing setae . . . . . 34. *P. kundipense*
34. Sporangia lacking setae, glands usually present . . . . . 35. *P. dryas*
33. Aerophores pale, slender, 1 mm long; sori near costules . . . . . 36. *P. croftii*

1. *Plesioneuron pullei* HOLTUM, *Blumea* 22 (1975) 236.—Type: PULLE 905, W. New Guinea, Mt Hellwig, 2600 m (L; BM).

*Caudex* short, massive, erect or suberect. *Stipe* of fertile fronds 25–30 cm long (shorter on sterile), red-brown, glossy, bearing many black spine-like scales 4 mm long, scale-bases persistent. *Lamina* to 30 cm long, texture coriaceous; pinnae 30 pairs or more (but see below); basal 2–3 pairs of pinnae variably somewhat reduced, lowest on a large frond 2.2 cm long, basal acroscopic lobe free and elongate. *Largest pinnae* 4.5 × 0.9–1.0 cm, sessile; aerophores not enlarged; base truncate; apex obtuse; edges lobed to 1 mm from costa or more deeply; lobes strongly concave on lower surface,

their edges much reflexed, entire, tips rounded; costules 2.5 mm apart; veins 4–5 pairs, thick and prominent beneath, invisible on upper surface, basal acroscopic vein passing to side of sinus-membrane, basal basiscopic vein arising from costa; *lower surface* of rachis bearing scattered glossy spine-like scales 1.5 mm long and stiff spreading hairs 0.7 mm long, costae and costules hairy as rachis, slender erect hairs present on surface between veins, copious hairs on and near margins of lobes; *upper surface* of costa deeply grooved with short hairs, capitate hairs present on rest of surface (often abraded on old specimens). *Sori* medial, exindusiate; sporangia lacking glands or setae.

Distr. *Malesia*: New Guinea; known from the type and PULLEN 5117 (see below).

Note. PULLEN 5117, from Western Highlands in Papua New Guinea, Kubor Range, at 3450 m, differs as follows: pinnae 18–20 pairs on a frond 30 cm long; costules 3–4 mm apart; veins 6–7 pairs; a very small hairy indusium present. The plant was on a steep bank near a rock-face in moss-forest, the fronds pendulous.

2. *Plesioneuron fuchsii* HOLTUM, *Blumea* 22 (1975) 236. —Type: H. P. FUCHS 21477, Sabah, Mt Kinabalu, North Face, Goking's valley, 2715 m (L; K, US).

*Caudex* not seen; *stipe* 60 cm long, densely covered throughout with erect black spines, mostly broken, all except basal ones terete with sparse setae; basal scales rigid, dark brown, 10–15 mm long, 0.5 mm wide, with sparse setae. *Lamina* to at least 75 cm long; pinnae 35 pairs or more, rigid when dry; basal pinnae a little narrowed at their bases. *Largest pinnae* 21 × 1.8 cm; base truncate; apex caudate-acuminate; edges lobed to 2.5–3 mm from costa; lobes slightly falcate, entire, ciliate; costules 4–4.5 mm apart; veins 10–11 pairs, prominent beneath, slightly impressed above, basal veins both touching sides of sinus-membrane; *lower surface* of rachis bearing black spines as stipe, also some intact scales which are 4 mm long distally to 7–8 mm at base of stipe, similar scales 4 mm long on costae; costae, costules, veins and surface between veins bearing rather sparse slender erect acicular hairs and a few capitate hairs; *upper surface* bearing terete scales on edges of the rachis-groove, on costae copious brown acicular hairs with a few on costules also. *Sori* about medial, small, exindusiate; sporangia bearing long setae.

Distr. *Malesia*: Sabah (Mt Kinabalu), 2 collections (the second is CLEMENS 33719).

Ecol. At 2300–2700 m, overhanging river in moss-forest.

3. *Plesioneuron medusella* HOLTUM, *sp. nov.*

*Caudex erectus, tenuis; stipes usque 25 cm longis, cum rachi omnino paleis angustis usque 8 mm longis vestitus; pinnae usque 9 × 1.2 cm, profundae lobatae; venae 6–7-jugatae, infimae ambae ad marginem terminatae; costae subius pilis usque 1 mm longis vestitae; sori parvi, prope costulas, exindusati; sporangia non setifera.* —Type: A. C. JERMY 14133, Sarawak, Gunong Mulu National Park, G. Api, 1500 m (BM).

*Caudex* erect, 10 mm diameter; *stipe* 12–25 cm long, densely scaly at base, more sparsely upwards and on rachis, largest scales c. 8 mm long, terete or flattened at the thickened base, above base to 0.4 mm wide, apex filiform; also on stipe slender acicular hairs and many short blunt or capitate hairs. *Lamina* to 35 cm long; pinnae c. 30 pairs, slightly overlapping; basal pinnae slightly

reduced and narrowed towards their bases, with elongate crenate basal acroscopic lobe. *Largest pinnae* 6.5–9 cm long, 1.2 cm wide above base; base truncate with both basal lobes a little longer than the next pair; apex evenly attenuate to tip; sides lobed to 1 mm from costa or more deeply, lobes not or slightly falcate; costules 2.5–3 mm apart, at more than 60° to costa; veins 6–7 pairs, prominent on lower surface, not on upper, basal veins both passing to margin above base of sinus; *lower surface* of rachis bearing scales 3–4 mm long, dark and very narrow, also sparse acicular hairs less than 1 mm long and more abundant short blunt or ± capitate hairs, hairs on costae similar but sometimes a little shorter, sparse acicular and more abundant short capitate hairs present on surface between veins; *upper surface* of rachis and costae with more abundant acicular hairs, few on costules and veins, between veins many short capitate hairs and a few acicular ones (often abraded from old fronds). *Sori* small, near costules except basal ones, exindusiate; sporangia sometimes bearing a shrivelled capitate hair; spores black, spinulose.

Distr. *Malesia*: Borneo (Sarawak: Mt Mulu, 1500 m), only known from the type.

Ecol. "In *Pandanus* zone over limestone pinnales; in crevices of limestone getting considerable light".

Note. The specific epithet refers to the dense spreading slender scales which cover the uncoiling young fronds in a medusa-like manner.

4. *Plesioneuron woodlarkense* (COPEL.) HOLTUM, *Blumea* 22 (1975) 236. —*Cyathea woodlarkensis* COPEL. Philip. J. Sci. 9 (1914) Bot. 1; HOLTUM, Fl. Males. II, 1, pt 2 (1963) 158. —Type: C. KING 384, Woodlark Island, d'Entrecasteaux Is. (MICH; NSW).

*Caudex* erect, 22 cm tall (FLOYD); *stipe* to 100 cm long, bearing very short acicular hairs and short black spines throughout, scales (fully persistent at base of stipe) c. 12 mm long, dull brown, terete at base, flat but less than 0.5 mm wide above base, terete distally, bearing short acicular hairs; *rachis* also bearing scattered short black spines on lower surface, on upper surface some complete bristle-like scales. *Lamina* to 150 cm long, texture firm-herbaceous; pinnae many pairs; basal pinnae with stalks 3 mm long, gradually narrowed in basal 4–5 cm, basal lobes 5–7 mm long. *Largest pinnae* 42 × 4.5 cm; base truncate; apex caudate-acuminate; edges lobed to 1–2 mm from costa, lobes slightly falcate on both sides of the costa; costules 5 mm apart, almost at right angles to costa; veins to more than 30 pairs, slender, basal ones touching sides of sinus-membrane; *lower surface* of rachis and costae bearing rather sparse pale hairs 1 mm long, shorter hairs on costules and veins, and a few on surface between veins; *upper surface* of costae bearing dense red-

dish hairs 1 mm long, shorter hairs scattered on veins and surface between them. *Sori* near costules, exindusiate; sporangia not setiferous; spores dark.

Distr. *Malesia*: Papua New Guinea (Woodlark Island, New Britain, New Ireland) at 700–900 m.

Notes. In 1914 COPELAND wrongly cited the number 284 for the type; he again cited the type wrongly, as 383, in Philip. J. Sci. 77 (1947) 124. Of other specimens, CROFT 322 from southern New Ireland, exactly matches the type; FLOYD 6529, from New Britain, agrees in details of indument and sori but has pinnae to  $33 \times 3$  cm. It should be noted that the number 384 occurs also on some specimens which do not belong here; at L, a specimen of *Amphineuron ceramicum*, at P a specimen of *A. immersum*.

**5. Plesioneuron dryopteroidum** (BRAUSE) HOLTUM, Blumea 22 (1975) 237. —*Alsophila dryopteroides* BRAUSE, Bot. Jahrb. 56 (1920) 70. —*Cyathea atrispora* DOMIN, Acta Bot. Bohem. 9 (1930) 95, nom. nov. —*Dryopteris atrispora* (DOMIN) C. CHR. Brittonia 2 (1937) 296. —*Thelypteris dryopteroides* (BRAUSE) REED, Phytologia 17 (1968) 273. —Type: LEDERMANN 11897, N.E. New Guinea, Sepik Distr. 2070 m (B).

#### KEY TO THE VARIETIES

1. Stipe-scales 10 mm long; acicular hairs on lower surface of costae to 0.5 mm long.
2. Acicular hairs present on lower surface of rachis and costae . . . . . **a. var. dryopteroidum**
2. Hairs on lower surface of rachis and costae not acicular . . . . . **b. var. buruense**
1. Stipe-scales to 18 mm long; acicular hairs on lower surface of costae 1 mm long

#### **c. var. pilosum**

#### **a. var. dryopteroidum**

*Caudex* erect, to at least 30 cm tall; *stipe* 60–120 cm long, basal part densely covered with dark brown rigid glossy scales c. 10 mm long, at least 1 mm wide with attenuate apex, distal part of stipe and both surfaces of rachis bearing less abundant similar but shorter scales or their spine-like bases. *Lamina* to 100 cm or more long, texture firm; lower pinnae narrowed towards their bases, with stalks 2 mm long. *Largest pinnae* commonly  $20 \times 2$  cm, largest on type  $35 \times 2.7$  cm; apex acuminate with cauda to 3 cm long; edges lobed to c. 2 mm from costa; lobes falcate, entire or slightly crenate, ciliate; costules 3.5–4.5 mm apart, at more than  $60^\circ$  to costa; veins commonly 12–15 pairs, basal veins both passing to sides of sinus-membrane; lower surface of rachis and costae bearing narrow dark scales and short acicular hairs, a few short acicular hairs present on costules with a variable number of small sessile or subsessile glands which in some

specimens are much swollen and yellow (apparently infected by a fungus), between veins rather sparse short erect hairs; on upper surface acicular hairs confined to rachis and costae, or with a few short ones on costules. *Sori* near costules, exindusiate; sporangia bearing neither setae nor glands; spores dark, spinulose.

Distr. *Malesia*: Eastern New Guinea, at 2000–2700 m.

#### **b. var. buruense** HOLTUM, var. nov.

*A typo speciei differt: rachi costisque subtus pilis brevibus capitatis solum vestitis.* — Type: STRESEMANN 387, N.W. Buru, G. Fogha, 1900 m (L).

Known only from the type collection which consists of part of a frond with pinnae to  $20 \times 2$  cm.

Distr. *Malesia*: Moluccas (Buru I.).

#### **c. var. pilosum** HOLTUM, var. nov.

*A typo speciei differt: paleis stipitis usque 18 mm longis; costis costulisque subtus pilis 1 mm longis copiose vestitis.* — Type: J. R. CROFT LAE 68379, New Ireland, Hans Meyer Range, 1700 m “landslip community” (L).

Known only from the type collection; stipe 50 cm long, lamina 150 cm long; largest pinnae  $25 \times 2.2$  cm; veins 18 pairs.

Distr. *Malesia*: E. New Guinea (New Ireland).

**6. Plesioneuron varievestitum** (C. CHR.) HOLTUM, comb. nov. —*Dryopteris atrispora* var. *varievestita* C. CHR. Brittonia 2 (1937) 296. —*Lastrea varievestita* (C. CHR.) COPEL. Gen. Fil. (1947) 140; Philip. J. Sci. 78 (1951) 429. —*Thelypteris varievestita* (C. CHR.) REED, Phytologia 17 (1968) 323. —Type: BRASS 4996, E. New Guinea, Mt Tafa, 2400 m (BM; BO, BRI).

#### KEY TO THE VARIETIES

1. Rachis and costae bearing acicular hairs on lower surface . . . . . **a. var. varievestitum**
1. Rachis and costae bearing only short, blunt or capitate, hairs on lower surface

#### **b. var. obtusipilum**

#### **a. var. varievestitum**

*Caudex* to 100 cm tall; *stipe* 47–70 cm long, stramineous above base, base densely covered with glossy castaneous scales to  $10 \times 2$  mm, scattered smaller scales or their broken spine-like bases present on distal part of stipe and on rachis and costae. *Lamina* 40–75 cm long, texture rigid; pinnae to more than 30 pairs; basal pinnae somewhat narrowed towards their bases, with stalks 1 mm long. *Largest pinnae* of type  $15 \times 1.5$  cm (of other specimens ranging from  $7.5 \times 1.2$  to  $21 \times 2.3$  cm); apex acuminate, with or without a short cauda; edges lobed to less than 1 mm from costa; lobes slightly falcate, entire; costules 3–4.5 mm apart; veins of type 9–10 pairs (on another speci-

men to 15 pairs), basal acroscopic vein ending beside sinus-membrane or near it, basiscopic vein at margin above base of sinus; *lower surface* of rachis bearing acicular hairs to 0.7 mm long, of costae and costules shorter acicular hairs and small colourless or yellow sessile or subsessile glands, between veins a variable number of short erect acicular hairs and a few glands; *upper surface* of rachis and costae bearing acicular hairs, between veins a variable number of small sessile glands. *Sori* near costules; indusia small, thin, pale, with a few glands or very short acicular hairs; sporangia sometimes bearing short capitate hairs or a short seta (not seen on type); spores dark, spinulose.

Distr. *Malesia*: Eastern New Guinea, at 1800–2800 m.

Notes. CHRISTENSEN and COPELAND failed to see the indusia, which are partly obscured by the developing sporangia. As in *P. dryopteroides*, the small glands on pinnae are sometimes swollen and yellow, perhaps through infection by a fungus.

**b. var. obtusipilum** HOLTUM, var. nov.

*A typo speciei differt: rachi costisque subtus pilis 0.1 mm longis vel capitatis vel obtusis praedita; pagina inferiore pinnarum inter venas pilis acicularibus brevibus pilis brevioribus capitatis intermixtis vestita.* — Type: NAKAIKE 80, N.E. New Guinea, Morobe Distr., Wau Subdistr., 1300–1600 m (K).

Scales on stipe much fewer than on *var. variegatum*, and thinner; lower surface of rachis and costae lacking acicular hairs but bearing many blunt or capitate hairs c. 0.1 mm long; between veins on lower surface of pinnae very copious erect acicular hairs and shorter capitate hairs (not sessile glands); indusia lacking acicular hairs; sporangia apparently lacking capitate hairs or setae.

Distr. *Malesia*: Papua New Guinea; known from type and STREIMANN & KAIRO NGF 44469, also from Wau Subdistrict, at 1500 m, in abandoned garden site (K).

Note. The short blunt hairs on these plants resemble those on *Chingia supraspinigera*. They appear to develop a waxing covering of their tips when old.

**7. Plesioneuron notabile** (BRAUSE) HOLTUM, Blumea 22 (1975) 237. — *Dryopteris notabilis* BRAUSE, Bot. Jahrb. 56 (1920) 91. — *Lastrea notabilis* (BRAUSE) COPEL. Gen. Fil. (1947) 139; Philip. J. Sci. 78 (1951) 429. — *Thelypteris notabilis* (BRAUSE) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 253. — Type: LEDERMANN 11663, N.E. New Guinea, Sepik Distr., Schraderberg, 2070 m (B).

*Caudex* not known. *Stipe* and frond together 3–4 m long; *stipe* seen 75 cm long, densely covered with erect black hair-pointed spines to

2 cm long, bearing short acicular hairs. *Lamina* very firm; basal pinnae somewhat reduced, with basal acroscopic lobe 7 × 1.4 cm and pinnatifid (*teste* BRAUSE); suprabasal pinnae opposite, 4–10 cm apart. *Largest pinnae* 38 × 11.5 cm, lobes in basal half or more separately adnate to costa and distinctly auricled on their basiscopic bases, the basal vein forked or pinnate in the auricle, lobes of distal part of pinna connected by a very narrow wing along the costa; costules to 1.7 cm apart (11 mm on smaller pinnae); veins to more than 30 pairs, slender and prominent both sides; *lower surface* glabrous except for hairs on margins of lobes and sometimes a few on costules; *upper surface* glabrous except for hairs on costae and costules. *Sori* large, near costules, exindusiate; sporangia not setiferous; spores very dark, minutely verrucose.

Distr. *Malesia*: Papua New Guinea. Known only from type and another collection from same locality (LEDERMANN 11991).

**8. Plesioneuron septempedale** (ALSTON) HOLTUM, Blumea 22 (1975) 238. — *Dryopteris septempedalis* ALSTON, J. Bot. 78 (1940) 227; Nova Guinea n.s. 4 (1940) 111, t. 8, f. 11. — Type: L. E. CHEESMAN 1383, W. New Guinea, Japen I. (BM; LAE).

*Caudex* not known; frond with stipe 215 cm long (collector); base of *stipe* bearing many dark spine-like bases of scales which bear short rigid hairs; pinnae almost opposite, widely spaced, lower ones slightly reduced, texture rigid. *Largest pinnae* 40 × 12 cm; base somewhat narrowed, basal lobes ± deflexed; apex short-acuminate; edges lobed to within 1 mm from costa; lobes at right angles to costa, acuminate, entire; costules to 12 mm apart; veins to more than 50 pairs, immersed and only just visible on surface; *lower surface* quite glabrous; *upper surface* of costae and costules bearing sparse short hairs. *Sori* near costules, basal ones divergent, exindusiate; neither setae nor glands on sporangia; spores dark.

Distr. *Malesia*: New Guinea (Japen I.), only known from the type.

**9. Plesioneuron marattioides** (ALSTON) HOLTUM, Blumea 22 (1975) 238. — *Dryopteris marattioides* ALSTON, J. Bot. 78 (1940) 227; Nova Guinea n.s. 4 (1940) 110, pl. 7, f. 7, 8. — Type: CLEMENS 4809, N.E. New Guinea, Morobe Distr., Sambanga (BM). — Fig. 9a–c.

*Caudex* to 30 cm tall (HOOGLAND & PULLEN); *stipe* 100 cm or more long, pale, minutely hairy, densely covered near base with erect dark spines, less densely upwards and on rachis, spines to 8 mm long, terete to their tips and bearing short hairs throughout; scales at base of stipe to at least 20 mm long, medium brown, glossy, 2 mm wide near base, apex filiform, bearing short stiff hairs especially on margins. *Lamina* to 200 cm or more long, thick; pinnae 25 pairs or more, all sub-opposite, several pairs of lower pinnae gradually

reduced, lowest 20 cm long. *Largest pinnae* 40 cm long, 8–11 cm wide, lobes separately adnate to costa in basal half of pinna, largest lobes  $5.8 \times 0.9$  cm, acuminate, those near base deflexed and somewhat reduced; distal half of pinna lobed almost to costa; costules to 10 mm apart near base of pinna; veins 35–40 pairs or more, thick and slightly prominent, basal acroscopic vein in larger lobes sometimes forked; *lower surface* quite glabrous apart from short hairs on margins of lobes; *upper surface* of costa densely covered with thick dark brown hairs, a few shorter hairs also on costules. *Sori* near costules except basal ones, exindusiate; no hairs nor glands on sporangia; spores dark with many small wings of irregular shape.

Distr. *Malesia*: N.E. New Guinea, at 1800–2300 m, several collections from widely separated localities, in *Nothofagus* forest.

Note. Young plants were grown from spores at Kew but died after attaining a height of 30 cm. They had rather abundant short orange capitate hairs on the lower surface of costules and veins, also a few between veins; such hairs are probably abraded from fronds of mature plants.

**10. *Plesioneuron fulgens* (BRAUSE) HOLTUM**, *Blumea* 22 (1975) 238. — *Dryopteris fulgens* BRAUSE, Bot. Jahrb. 56 (1920) 89. — *Thelypteris fulgens* (BRAUSE) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 251. — Type: LEDERMANN 11004, N.E. New Guinea, Sepik Distr. 1300 m (B).

*Dryopteris hunsteiniana* BRAUSE, Bot. Jahrb. 56 (1920) 79. — *Thelypteris hunsteiniana* (BRAUSE) REED, *Phytologia* 17 (1968) 284. — Type: LEDERMANN 11058, loc. as *D. fulgens* (B).

*Mesoneuron wantotense sensu* HOLTUM, *Blumea* 13 (1965) 134. — Fig. 1j.

*Caudex* creeping, 4–5 mm diameter; *stipe* 25–60 cm long, smooth except base, basal scales  $11 \times 1.5$  mm, stiff, hairy. *Lamina* 30–45 cm long, very firm; pinnae 4–5 pairs, lowest pinnae a little narrowed towards their bases; apex of lamina pinna-like. *Largest pinnae* 16–20 cm long, 3.5–4.2 cm wide; apex acuminate with subentire cauda 2–3 cm long; edges lobed to 2–3 mm from costa; lobes equal and slightly falcate on the two sides of costae; costules 7 mm apart, at a wide angle to costa; veins 16–20 pairs, basal acroscopic vein touching side of sinus-membrane which is decurrent as a ridge on the lower surface almost to the costa, basal basicopic vein arising from the costa; *lower surface* sparsely hairy on sinus-membranes and margins of lobes, sometimes a few hairs also on costules; *upper surface* with coarse dark brown hairs on costa. *Sori* near but not touching costules; indusia firm, dark, with a few short hairs; slender acicular hairs present on receptacle with sporangia; sporangia with either a seta or a gland; spores dark with rather well-spaced short spines.

Distr. *Malesia*: Eastern New Guinea.

Ecol. At 1300–2000 m, on steep banks of

streams, sometimes among rocks, in forest.

**11. *Plesioneuron belense* (COPEL.) HOLTUM**, *Blumea* 22 (1975) 239. — *Dryopteris belensis* COPEL. Univ. Cal. Publ. Bot. 18 (1942) 220. — *Lastrea belensis* COPEL. Gen. Fil. (1947) 138; Philip. J. Sci. 78 (1951) 433, pl. 21. — *Thelypteris belensis* (COPEL.) REED, *Phytologia* 17 (1968) 263. — Type: BRASS 11509, W. New Guinea, Bele River (MICH; L).

*Caudex* stout, suberect; *stipe* 40 cm long, dark-hairy in groove only, bearing small (not spine-like) scales almost throughout, basal scales  $4 \times 1.5$  mm, not thick. *Lamina* 45 cm long; pinnae 12–15 pairs, not opposite; texture very firm. *Largest pinnae*  $15 \times 3$  cm; base broadly cuneate to rounded, with one pair of lobes somewhat reduced; apex caudate-acuminate; edges lobed to 2 mm from costa, lobes on acroscopic side falcate near their tips only, those on basicopic side distinctly falcate from their bases but not shorter; costules 5 mm apart; veins to 18 pairs, basal pair passing to sides of the sinus-membrane which is decurrent between them; *lower surface* of rachis and costae bearing scattered stiff brown hairs and also narrow scales with marginal setae, costules similar but scales very small; *upper surface* of costae brown-hairy near their bases only, rest of pinna glabrous. *Sori* near costules, exindusiate; some acicular hairs present on receptacle with the sporangia; sporangia not setiferous, no glands seen on them; spores dark, large, closely and minutely papillose.

Distr. *Malesia*: West New Guinea (Bele R.). Known only from the type and another specimen (BRASS 11327) from the same place.

Ecol. On limestone cliff in forest at 2200 m.

Note. COPELAND stated that small deciduous setulose indusia were present; my observation of the type is that the only hairs are on the receptacle, as in several other species of this genus.

**12. *Plesioneuron wariense* (COPEL.) HOLTUM**, *Blumea* 22 (1975) 239. — *Dryopteris wariensis* COPEL. Philip. J. Sci. 6 (1911) Bot. 73. — *Lastrea wariensis* COPEL. Gen. Fil. (1947) 146. — *Thelypteris wariensis* (COPEL.) REED, *Phytologia* 17 (1968) 324. — Type: C. KING 101, p.p., N.E. New Guinea, Waria River (MICH; NSW).

*Caudex* not seen, nor base of stipe. *Lamina* 60 cm long; pinnae 8 pairs; basal pinnae with stalks 4 mm long, basal 4 pairs of lobes gradually reduced, successive pinnae with shorter stalks and fewer reduced basal lobes; apex of frond pinna-like. *Largest pinnae* 18–30 cm long, to 3.5 cm wide; aerophores not swollen; apex acuminate; edges lobed to 0.5 mm from costa, lobes slightly falcate, about equal on the two sides of the costa; costules to 5 mm apart; veins 17–20 pairs, concolorous and very prominent on lower surface, less so on upper, both basal veins passing to margin above base of sinus, sinus-membrane very

short but distinct; *lower surface* of rachis distally bearing many thick light brown hairs, rest of rachis and costae with sparse short hairs, no scales seen; *upper surface* of costae covered with very short hairs and scattered hairs 1 mm long, rest glabrous. *Sori* medial, rather large, exindusiate; no hairs seen on receptacle; sporangia bearing yellow glands, often 2; spores not seen.

Distr. *Malesia*: Papua New Guinea. Known from two collections by C. KING (second is n. 430).

Notes. A specimen of KING 101 at Bogor is *P. tuberculatum*. The latter differs from *P. wariense* in having sori near costules and small caducous indusia. The sori of the type of *P. wariense* are not quite mature.

**13. *Plesioneuron royenii* HOLTUM**, Blumea 22 (1975) 240. — Type: VAN ROYEN 5469, W. New Guinea, Waigeu Island (L).

*Caudex* short-creeping; *stipe* to 40 cm long, basal scales  $6 \times 1$  mm, setose. *Lamina* 22–27 cm long; pinnae 6 pairs; basal pinnae with stalks 1.5–2 mm long, basal 2–3 pairs of lobes gradually reduced, basal acroscopic lobe free, entire, 5 mm long; apex of frond almost pinna-like but widened at its base with some transition to upper pinnae. *Largest pinnae* 9–10 cm long, sterile to 2.8 cm wide, fertile to 2.3 cm; base subtruncate; apex acuminate with cauda 10 mm long; edges lobed to 1.5 mm from costa; lobes on both sides of costa alike, oblique and slightly falcate; costules 3.5 mm apart (fertile) to 4.5 mm (sterile); veins 11–12 pairs, both basal veins passing to margin above base of sinus; *lower surface* of rachis and costae bearing abundant very short erect hairs, distally on costae also a few longer hairs, few minute hairs on costules, rest of surface glabrous and slightly pustular; *upper surface* short-hairy on costae only. *Sori* supramedial, exindusiate, without hairs on receptacle; sporangia with 1–3 short setae; spores not seen.

Distr. *Malesia*: West New Guinea (Waigeu I.), only known from the type.

Ecol. In forest at 3 m altitude.

**14. *Plesioneuron savaiense* (BAK.) HOLTUM**, Blumea 22 (1975) 240. — *Nephrodium savaiense* BAK. Ann. Bot. 5 (1891) 318. — *Dryopteris savaiensis* (BAK.) C. CHR. Ind. Fil. (1905) 291; Bishop Mus. Bull. 177 (1943) 82. — *Thelypteris savaiensis* (BAK.) REED, Phytologia 17 (1968) 312. — Type: POWELL 183, Samoa (K).

*Dryopteris quadriaurita* CHRIST, Philip. J. Sci. 2 (1907) Bot. 209. — *Lastrea quadriaurita* (CHRIST) COPEL. Gen. Fil. (1947) 139; Fern Fl. Philip. (1960) 326. — *Thelypteris quadriaurita* (CHRIST) REED, Phytologia 17 (1968) 307. — Type: COPELAND 1714, Mindanao, San Ramon 850 m (US; B, P).

*Dryopteris ensipinna* BRAUSE, Bot. Jahrb. 56

(1920) 84. — *Thelypteris ensipinna* (BRAUSE) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 251. — Type: LEDERMANN 12773, N.E. New Guinea, Sepik Distr. 1400 m (B). — Fig. 9g-i.

*Caudex* short, creeping or suberect; *stipe* 20–50 cm long,  $\pm$  short-hairy at least distally, basal scales to  $12 \times 1$  mm, firm, densely covered with short hairs. *Lamina* 30–40 cm long; pinnae 12–15 pairs; basal pinnae sessile, basal 1–2 pairs of lobes  $\pm$  reduced (more on basiscopical than on acroscopic side), basal acroscopic lobe free or nearly so, sometimes with a toothed margin. *Largest pinnae* 10–12  $\times$  2.0–2.5 cm; apex acuminate, sometimes with a short cauda; edges lobed to 1 mm from costa or more deeply, lobes on acroscopic side of costa somewhat oblique, straight, those on basiscopical side slightly falcate; costules 3.5–5 mm apart; veins 10–12(–15) pairs, concolorous and slightly prominent, basal pair both ending above base of sinus; *lower surface* of rachis, costae and costules  $\pm$  densely covered with short stiff hairs of varying length to 0.5 mm, some hairs also on veins and on surface between them; *upper surface* usually hairy on rachis and costae only. *Sori* medial; indusia variable but always small, with stiff marginal hairs, absent on some specimens from New Guinea and the Moluccas; sporangia bearing several rather long setae; spores dark, spinulose.

Distr. Samoa, New Hebrides, and *Malesia*: New Guinea, Philippines (Mindanao, Negros), Moluccas (Batjan, Amboina).

Ecol. In New Guinea at 850–1500 m, in primary or secondary forest.

Notes. One collection by NAKAIKE from 1500 m in New Guinea has the largest pinnae  $4.5 \times 1.0$  cm and very narrow scales 10 mm long. A Philippine specimen has much less hairy scales than any from New Guinea.

**15. *Plesioneuron altum* (BRAUSE) HOLTUM**, Blumea 22 (1975) 241. — *Dryopteris alta* BRAUSE, Bot. Jahrb. 56 (1920) 86. — *Lastrea alta* (BRAUSE) COPEL. Philip. J. Sci. 78 (1951) 429. — *Thelypteris alta* (BRAUSE) REED, Phytologia 17 (1968) 259. — Type: LEDERMANN 11497, N.E. New Guinea, Sepik Distr. 1300 m (B).

*Caudex* short-creeping, apical scales to  $10 \times 1.5$  mm, rigid, bearing short hairs; *stipe* 70 cm long, glabrescent, scaly near base only. *Lamina* 70 cm long; pinnae 14 pairs; several pairs of lower pinnae with stalks 3–4 mm long, only distal ones sessile; basal acroscopic lobe of basal pinnae little reduced, basal basiscopical lobe 12 mm long, apex of frond not pinna-like. *Largest pinnae*  $21 \times 3.3$  cm; aerophores dark and slightly swollen; apex caudate-acuminate, cauda to 2.5 cm; edges lobed to less than 1 mm from costa; lobes on acroscopic side of costa almost straight, those on basiscopical side rather strongly falcate but little shorter than acroscopic lobes; costules to 6.5 mm apart; veins



to 16 pairs, prominent both sides, basal ones not meeting the distinct short-hairy sinus-membrane; *lower surface* sparsely hairy on costae and costules, short hairs present on margins of lobes; *upper surface* of rachis and costae densely hairy, of costules sparsely, scattered short hairs present on surface between veins. *Sori* near costules; indusia very small, hairy; sporangia setiferous, with acicular hairs on their stalks; spores dark, finely spinulose.

Distr. *Malesia*: Papua New Guinea; only known from the type.

Note. BRAUSE stated that he saw no indusia, but I observed them on the type. In frond-form this is near *P. tuberculatum*, but the latter differs in less deeply lobed pinnae, more distinct (though caducous) indusia, and glandular sporangia.

**16. *Plesioneuron cystodioides* HOLTUM, sp. nov.**

*Pinnae* usque  $12 \times 2.5$  cm, subsessiles, fere ad costam lobatae, lobis acroscopicis et basiscopicis aequaliter leviter falcatis, lobis infimis acroscopicis variabile elongatis; venae usque 15-jugatae; rachis costaeque subtus pilis 0.1 mm longis praedita; sori submarginales, indusia magna, marginem superantia; sporangia nec setifera nec glandulosa. — Type: T. NAKAIKE 50, N.E. New Guinea, near Wau (K; TNS).

*Caudex* not known; *stipe* 45 cm long, glabrous except distally; basal scales to  $9 \times 1$  mm, very thick at base, thinner distally and narrowly attenuate, sparsely hairy. *Lamina* to 62 cm long; pinnae 12–18 pairs, basal ones only subopposite; basal pinnae sessile or nearly so, basal basiscopic lobe a little reduced, basal acroscopic lobe elongate, lobed, with pinnate veins in the lobes, to  $2.5 \times 0.5$  cm; basal acroscopic lobe of suprabasal pinnae sometimes  $\pm$  elongate. *Largest pinnae*  $12 \times 2.5$  cm; apex caudate-acuminate, cauda 2 cm long, 1 mm wide; edges lobed almost to costa; lobes about equal on the two sides of the costa, separated by rather wide sinuses, slightly falcate (basiscopic lobes little more so than acroscopic), edges cartilaginous and slightly sinuous; costules 4–5 mm apart; veins to 15 pairs, basal ones passing to margin above base of sinus, concolorous and prominent on both surfaces; *lower surface* of rachis bearing erect hairs 0.1 mm long with a few thicker brown ones, costal and costular hairs a little longer, sparse hairs present on veins and a few between veins; *upper surface* of rachis and costae covered with erect hairs 0.2 mm long, minute hairs also on costules. *Sori* almost at the ends of the veins; indusia large, firm, glabrous, overlapping margins of pinna-lobes; no glands seen on sporangia; spores minutely spinulose.

Distr. *Malesia*: Papua New Guinea, only known from the type.

Note. The form of the pinna-lobes, with their marginal sori, is very similar to that of pinna-lobes of *Cystodium sorbifolium*.

**17. *Plesioneuron subterminale* HOLTUM**, Blumea 22 (1975) 241. — Type: BRASS 32049, N.E. New Guinea, Eastern Highlands, 1400 m (K).

*Caudex* suberect; scales to  $10 \times 1$  mm, thick at base, narrowed and thinner distally, bearing short hairs; *stipe* to 70 cm long, glabrescent except in groove. *Lamina* to 80 cm long, very firm; pinnae to c. 25 pairs; basal pinnae of type with stalks 2–3 mm long, of other specimens subsessile, basal 1–2 pairs of lobes somewhat reduced; aerophores slightly elongate. *Largest pinnae*  $20 \times 3$  cm; apex acuminate, sometimes caudate; edges lobed to 1–1.5 mm from costae, lobes on acroscopic side slightly falcate distally, those on basiscopic side falcate from their bases; costules to 5 mm apart; veins to 20 on basiscopic side of costules, to 18 on acroscopic side, prominent both sides, basal acroscopic veins usually ending near sinus-membrane; *lower surface* of rachis densely covered with erect hairs 0.3 mm or more long, a variable number being rather thick and brown, costal hairs as rachis but antrorse distally, costular hairs more sparse, sparse and variable on and between veins; *upper surface* hairy about as lower, in some cases more and longer brown hairs present on rachis. *Sori* supramedial but not marginal; indusia firm, with many short hairs; acicular hairs rare on receptacle; sporangia sometimes with a small gland; spores dark, minutely spinulose.

Distr. *Malesia*: Papua New Guinea (Eastern Highlands and near Wau), in forest at 1200–2200 m.

**18. *Plesioneuron bipinnatum* (COPEL.) HOLTUM**, Blumea 22 (1975) 242. — *Dryopteris bipinnata* COPEL. Philip. J. Sci. 9 (1911) Bot. 2. — *Lastrea bipinnata* COPEL. Philip. J. Sci. 78 (1951) 422. — *Thelypteris bipinnata* (COPEL.) REED, Phytologia 17 (1968) 264. — Type: C. KING 407, E. New Guinea, Loane (MICH).

*Caudex* not known; *stipe* 32 cm long, closely and minutely hairy; basal scales 5 mm long, narrow, hairy. *Lamina* 28 cm long, texture rather thin; pinnae 10–11 pairs. *Basal pinnae* largest, with stalk 1 mm long; basal pair of lobes free, short-stalked, 3–4 mm long, next pair of lobes almost free and longer, rest of pinna lobed almost to costa; apex acuminate with sinuous cauda 1.5 cm long; lobes slightly falcate, about equal on the two sides of the costa; costules to 3 mm apart; veins to 11 pairs, concolorous and prominent both sides, basal veins both passing to margin above base of sinus except near apex of pinnae; *lower surface* of rachis and costae bearing very short and scattered longer erect hairs, hairs on costules similar, few on veins; hairs on *upper surface* of costae as lower but antrorse. *Sori* supramedial, impressed (prominent on the upper surface); indusia small with many short hairs; no glands or setae seen on sporangia.

Distr. *Malesia*: Papua New Guinea. Known

only from the type and KING 221, from the extreme east of New Guinea, opposite Samarai island.

Note. These lowland coastal plants may represent the same species as the larger ones from mountains described here as *P. subterminale*.

**19. *Plesioneuron quadriquetrum* (v.A.v.R.) HOLTUM**, *Blumea* 22 (1975) 242. — *Dryopteris quadriquetra* v.A.v.R. *Nova Guinea* 14 (1924) 16. — *Thelypteris quadriquetra* (v.A.v.R.) CHING, *Bull. Fan Mem. Inst. Biol. Bot.* 10 (1941) 254. — Type: LAM 542, W. New Guinea, Mamberamo River, 10 m (L).

*Caudex* suberect; *stipe* 20–40 cm long, glabrous except for hairs in the groove, basal scales 6 mm long, narrow, hairy. *Fronde* subdimorphous, sterile to 25 cm long with 7–8 pairs of pinnae, fertile with 10 pairs; basal pinnae with 2–3 pairs of basal lobes reduced; apex of frond not pinna-like. *Sterile pinnae* to 10 × 2.0 cm; apex acuminate with cauda 1.5 cm long; edges lobed to 1 mm from costa; lobes slightly oblique, hardly falcate, about equal on the two sides of the costa; costules 4 mm apart; veins 10–12 pairs, basal veins usually both passing to margin above base of sinus; lower surface of costa bearing rather sparse erect hairs nearly 1 mm long and more abundant shorter ones, short hairs also on costules; upper surface of costae hairy as lower. *Fertile pinnae* to 8 × 1.2 cm; costules 3–3.5 mm apart; lobes well separated; sori supramedial; indusia firm, persistent, with short brown hairs; sporangia sometimes bearing a small colourless gland; spores with a translucent wing and cross-wings.

*Distr. Malesia*: West New Guinea; only known from the type.

*Ecol.* LAM's label records the type as growing epiphytically; confirmation of this unusual habitat is desirable.

Note. The spores resemble those of *P. archboldiae* (COPEL.) HOLTUM from Fiji and *P. phanerophlebium* (BAK.) HOLTUM from the Solomon Islands.

**20. *Plesioneuron falcatipinnulum* (COPEL.) HOLTUM**, *Blumea* 22 (1975) 244. — *Dryopteris falcatipinnula* COPEL. *Philipp. J. Sci.* 6 (1911) Bot. 74. — *Lastrea falcatipinnula* (COPEL.) COPEL. *Gen. Fil.* (1947) 138; *Philipp. J. Sci.* 78 (1951) 433. — *Thelypteris falcatipinnula* (COPEL.) REED, *Phytologia* 17 (1968) 276. — Type: C. KING 114, Eastern New Guinea, in lowlands (MICH; BO).

*Caudex* not known; *stipe* 30 cm long, glabrous; basal scales 4 mm long, very narrow, rather thin. *Lamina* 30 cm long, very firm; pinnae 8 pairs, opposite, well-spaced, apical pair much reduced and unequal. *Largest pinnae* 12 × 1.5 cm; aerophores swollen but not elongate; basal 1–2 pairs of lobes reduced (except on distal pinnae); apex acuminate with a cauda 10–15 mm long; edges

lobed to less than 0.5 mm from costa; lobes on both sides of costa oblique and much falcate; costules 3.5 mm apart; veins to 12 pairs, slender, concolorous, prominent, both basal veins passing to margin above base of sinus; lower surface of rachis and costae bearing copious short stiff pale hairs, similar hairs more sparse on costules; upper surface of pinnae hairy only on costae. *Sori* inframedial; indusia firm, short-hairy; sporangia bearing orange glands; spores not seen.

*Distr. Malesia*: Papua New Guinea, only known from the type.

**21. *Plesioneuron kostermansii* HOLTUM, sp. nov.**

*Stipes* 45–50 cm longus, omnino pilis erectis usque 1 mm longis vestitus; lamina c. 50 cm longa; pinnae 25-jugatae, usque 12 × 1.8 cm, lobis utrinque falcatis; venae 10-jugatae; rachis costaeque subtus pilis erectis variis usque 1 mm longis dense vestitae, venae subtus paginae inter venas pilis multis tenuibus erectis praeditae; pagina superior pinnae pilis adpressis 0.3 mm longis vestita; sori mediales, indusia parva, setosa; sporangia non setifera. — Type: KOSTERMANS & SOEGENG 142, W. New Guinea, above Jayapura (L; BO).

*Caudex* short, erect, massive; *stipe* 45–50 cm long, covered with slender spreading hairs to 1 mm long, basal scales c. 7 × 0.5 mm, firm, glossy, not thick. *Lamina* c. 50 cm long, rigid; pinnae c. 25 pairs; basal pair of lobes of basal pinnae reduced and free. *Largest pinnae* 12 × 1.8 cm, sessile; aerophores not elongate; apex acuminate; edges lobed to 1.5 mm from costa, lobes equally falcate on the two sides of the costa; costules 3 mm apart; veins 10 pairs, basal pair both passing to margin above base of sinus; lower surface of rachis and costae densely covered with erect pale hairs of varying length, to 1 mm long, veins and surface between them bearing erect slender hairs 0.5 mm long; upper surface of costa bearing pale hairs 1 mm long, whole surface of pinna covered with appressed hairs 0.3 mm long. *Sori* medial or a little inframedial; indusia rather small, firm, dark, with stiff hairs 0.2 mm long; sporangia not setose, no glands seen on them.

*Distr. Malesia*: West New Guinea, only known from the type.

*Ecol.* At 300 m, "on slope of limestone hill, very wet".

**22. *Plesioneuron angiensis* HOLTUM, sp. nov.**

*Stipes* 45 cm longus; lamina 55 cm longa; pinnae 24-jugatae, usque 12 × 2.1 cm, sessiles; venae 12–13-jugatae; rachis costaeque subtus pilis 0.3 mm longis erectis vestitae; pagina superior inter venas pilis brevibus erectis praedita; sori inframediales; indusia margine pilis brevibus fimbriata; sporangia nec setis nec glandulis praedita. — Type: KANEHIRA & HATUSIMA 13741, W. New Guinea, Arfak Mts, 1900 m (BO).

*Caudex* "60 cm high, 1.5 cm diameter" (collec-

tors' label); *stipe* 45 cm long, glabrous apart from brown hairs in the groove, basal scales not seen. *Lamina* 55 cm long, thin but firm; pinnae 24 pairs; lowest pinnae not well preserved; apex of frond pinna-like but larger than pinnae. *Largest pinnae* 12 × 2.1 cm, sessile; aerophores dark and slightly swollen; base of pinna truncate; apex short-acuminate; edges lobed to 1 mm from costa or more deeply; lobes falcate, about equally so on each side of costa, basal lobes not or little reduced; costules 4–4.5 mm apart, almost at right angles to costa; veins 12–13 pairs, slender and prominent both sides, basal acroscopic vein sometimes touching side of the short sinus-membrane; *lower surface* of costae densely covered with erect brown hairs 0.3 mm long with scattered longer ones, costal and costular hairs similar but less dense and mostly pale, no other hairs; *upper surface* of costae hairy as lower, rest of upper surface bearing scattered very short suberect hairs. *Sori* a little inframedial; a few acicular hairs present on receptacle; indusia rather small, dark, firm, fringed with stiff hairs 0.2 mm long; sporangia not setiferous, no glands seen on them; spores not seen.

Distr. *Malesia*: West New Guinea (Arfak Mts), only known from type.

Ecol. "Terrestrial in the poorly drained forest" near the "male" lake, 1900 m alt.

### 23. *Plesioneuron sandsii* HOLTUM, sp. nov.

*Stipes* 45 cm longus, *basi paleis* 5 × 1 mm *praeditus*; *lamina* 50 cm longa; *pinnae* 25-jugatae, *inferiores* 2-jugatae *redactae*; *pinnae maximae* 13.5 × 2.0 cm, *lobis inferioribus* 10–12-jugatis *singulatis ad costam adnatis*; *rachis costaeque subtus pilis brunneis erectis vestitae*, *costae etiam paleis angustis praeditae*; *sori inframediales*; *indusia firma, glabra*; *sporangia glandulis minutis praedita*. — Type: M. J. S. SANDS 2380 A, New Ireland, 2150 m (K).

*Caudex* short-creeping with stipes tufted at its apex; *stipe* 45 cm long, covered throughout with stiff erect hairs 0.2–0.3 mm long, basal scales c. 5 × 1 mm, thick at base only, short-hairy, scales above base of stipe thin and translucent. *Lamina* 50 cm long, very firm; pinnae 25 pairs, basal 2–3 pairs irregularly reduced, lowest on one frond 3 × 1.2 cm, on another 7–8 cm long, basal acroscopic lobes of lower pinnae 7 mm long, basiscopic 3 mm; apex of frond not pinna-like. *Largest pinnae* 13.5 × 2.0 cm; apex acuminate, sometimes with cauda 2 cm long; edges lobed almost to costa in distal part of pinna, basal 10–12 pairs of lobes separately adnate to costa; lobes on acroscopic side almost all straight, to 12 mm long, on basiscopic side strongly falcate, to 10 mm long; costules to 5 mm apart; veins to 10 pairs, concolorous and prominent on upper surface, pale and less prominent on lower; *lower surface* of rachis densely covered with brown erect hairs 0.3 mm long, costae with shorter and less dense hairs, very

small brown scales also present on costae and costules, rest of surface glabrous; *upper surface* of costae covered with short brown hairs, rest glabrous. *Sori* inframedial; indusia dark, firm, glabrous; sporangia bearing very small elongate glands (much shrivelled); spores black, closely and minutely spinulose.

Distr. *Malesia*: Papua New Guinea (New Ireland), only known from the type.

24. *Plesioneuron tuberculatum* (CESATI) HOLTUM, *Blumea* 22 (1975) 246. — *Nephrodium tuberculatum* CESATI, *Rendic. R. Acad. Napoli* 16, fasc. 2 (1877) 26, 29. — *Dryopteris tuberculata* (CESATI) C. CHR. Ind. Fil. (1905) 299; *Dansk Bot. Ark.* 9, 3 (1937) 48, pl. V, f. 6. — *Thelypteris tuberculata* (CESATI) CHING, *Bull. Fan Mem. Inst. Biol. Bot.* 10 (1941) 255. — Type: BECCARI, W. New Guinea, Arfak Mts (FI; K).

*Dryopteris schlechteri* BRAUSE, *Bot. Jahrb.* 49 (1912) 16, f. 1E, incl. var. *djamuense*. — Type: SCHLECHTER 16188, N.E. New Guinea, near Ketel, 200 m (B; K, L).

*Dryopteris schizophylla* v. A. v. R. Nova Guinea 14 (1924) 19. — Type: LAM 772, W. New Guinea (BO; L). — Fig. 9d–f.

*Caudex* massive, erect; *stipe* to at least 75 cm long, glabrescent, basal scales to at least 7 mm long, narrow, thick. *Lamina* to 100 cm long; pinnae 20 pairs, all stalked except distal ones; basal pinnae with stalks 3–5 mm long, basal basiscopic lobe much reduced, acroscopic lobe not. *Largest pinnae* 25 × 5 cm; aerophores ± elongate; apex caudate-acuminate, cauda 2.5–5 cm long; edges lobed to 1–1.5 mm from costa; lobes on acroscopic side almost straight, on basiscopic side somewhat falcate and sometimes shorter; costules 5–7 mm apart, a small swelling at the base of each, at least near bases of pinnae; veins to 23 pairs, slender, concolorous, prominent both sides, basal acroscopic vein usually passing to side of sinus-membrane; *lower surface* of rachis glabrous, of costae and costules bearing sparse brown hairs (often persistent only on costules and appressed), surface between veins often strongly pustular; *upper surface* bearing short dark hairs on groove of rachis and on costae only. *Sori* near costules; indusia small, glabrous, soon caducous; sporangia bearing small red glands on body and a short acicular hair on stalk; spores dark, minutely spinulose.

Distr. *Malesia*: New Guinea and Moluccas (Batjan: ALSTON 16977).

Ecol. In forest, low country to 1200 m in New Guinea, at 2000 m in Batjan.

Note. The Batjan specimen differs in more deeply lobed pinnae, basal acroscopic lobe of basal pinnae free, sori not so near costules, with many acicular hairs on the receptacle.

25. *Plesioneuron attenuatum* (BRACK.) HOLT-

TUM, *Blumea* 22 (1975) 245; *Allertonia* 1 (1977) 191, f. 4, k-m, q.v. for synonymy in the Pacific. — *Lastrea attenuata* BRACK. in Wilkes, U.S. Expl. Exp. 16 (1854) 193, t. 26, f. 2. — *Aspidium brackenridgei* METT. Ann. Sci. Nat. Bot. IV, 15 (1861) 75, nom. nov. (not *A. attenuatum* Sw.). — *Thelypteris brackenridgei* (METT.) REED, *Phytologia* 17 (1968) 265. — Type: U.S. Expl. Exped. Tahiti (US).

*Caudex* erect or suberect; *stipe* to 80 cm long, glabrous, basal scales to 20 mm long, very narrow, rather thick and not glossy, with few hairs. *Lamina* to 120 cm long, very firm; pinnae 24 pairs or more, lower ones with stalks 2–3 mm long, all with basiscopic lobes strongly falcate and shorter than the almost straight acroscopic ones; basal acroscopic lobe on basal pinnae  $\pm$  reduced and separately adnate to costa; aerophores elongate, slender. *Largest pinnae*  $25 \times 3.2$  cm; apex gradually attenuate; edges lobed to 1 mm from costa or more deeply; acroscopic lobes to 2.2 cm long, narrowed to an acute tip, lobes on basiscopic side to 1.6 cm long; costules 4–5 mm apart; veins on acroscopic lobes to 22 pairs, slender and prominent both sides, basal acroscopic vein touching side of sinus-membrane which is pellucid and decurrent almost to the costa; *lower surface* of rachis sparsely short-hairy, glabrescent, of costae  $\pm$  densely hairy at base, sparsely distally, with hairs 0.3–0.5 mm long, narrow scales sometimes also present; *upper surface* hairy in groove of rachis and on costae, hairs pale, 0.5 mm long. *Sori* near costules; acicular hairs present with sporangia on receptacle; indusia firm, persistent, glabrous or variably short-hairy; sporangia bearing 2–3 small red glands; spores dark, minutely verrucose.

Distr. Pacific, from Tahiti westwards to *East Malesia*: New Guinea (New Ireland, New Britain).

Ecol. In New Ireland and New Britain, in forest at 1100–1300 m, at lower altitudes in the Solomon Islands.

**26. *Plesioneuron platylobum*** HOLTUM, *Blumea* 22 (1975) 246. — Type: JERMY 3610, N.E. New Guinea, Morobe Distr. (BM).

*P. ctenolobum* HOLTUM, *ibid.* 247. — Type: JERMY 3604, same locality (BM).

*Caudex* creeping, 1 cm diameter, bearing fronds to 2 cm apart; *stipe* 40–50 cm long, basal scales to  $6 \times 1.5$  mm, thick, hairy. *Lamina* 60–80 cm long, very firm; pinnae 20–30 pairs; basal pinnae with stalks 1 mm or less, their basal acroscopic lobes free, 2 cm long, 7–15 mm wide, with edges variably crenate or lobed and veins forked in the lobes, basal basiscopic lobes  $\pm$  reduced, sometimes free but not wider than the next lobes. *Largest pinnae*  $18\text{--}21 \times 3.5\text{--}4.0$  cm; basal lobes slightly reduced or not; apex acuminate and  $\pm$  caudate; edges lobed to 1 mm from costa or more

deeply; lobes on acroscopic side almost straight, on basiscopic side falcate but not shorter than acroscopic lobes; costules 4–6 mm apart; veins 18–22 pairs, basal acroscopic vein sometimes touching sinus-membrane; *lower surface* of rachis and costae variably short-hairy, few other hairs present; *upper surface* hairy on rachis and costae, some short hairs present on and between veins distally on lobes. *Sori* medial; indusia firm, large, with few to many short hairs; no acicular hairs on receptacle; sporangia bearing glands or setae; spores dark, minutely spinulose.

Distr. *Malesia*: Papua New Guinea, only known from the types.

Ecol. In *Castanopsis* forest at 1050 m.

**27. *Plesioneuron crassum*** (COPEL.) HOLTUM, *Blumea* 22 (1975) 243. — *Dryopteris crassa* COPEL. Univ. Cal. Publ. Bot. 18 (1942) 220. — *Lastrea crassa* COPEL. Gen. Fil. (1947) 138; Philip. J. Sci. 78 (1951) 435, pl. 23. — *Thelypteris crassa* (COPEL.) REED, *Phytologia* 17 (1968) 269. — Type: BRASS 10878, W. New Guinea, Lake Habbema, 2650 m (MICH; L).

*Caudex* creeping, 1 cm diameter; *stipe* 60 cm long, glabrous above base, basal scales to  $5 \times 1.5$  mm, thin except at base. *Lamina* to 28 cm long, texture rigid; pinnae 9 pairs, 2 basal pairs opposite, 1 pair basal lobes somewhat reduced on basal pinnae only. *Largest pinnae*  $11 \times 2$  cm; aerophores elongate to 1 mm; apex acuminate with short cauda; edges lobed to 0.5 mm from costa; lobes on acroscopic side hardly falcate, on basiscopic side distinctly but not strongly so, margins (reflexed on drying) with a wide cartilaginous band; costules 4–4.5 mm apart; veins thick, 12 pairs, both basal veins passing to margin above base of sinus; *lower surface* wholly glabrous except for a few dark hairs on margins of lobes; *upper surface* of rachis and costae bearing stiff dark hairs. *Sori* near costules; indusia small, dark, thick, glabrous; sporangia not setiferous, no glands seen on them; spores of type not seen.

Distr. *Malesia*: West New Guinea. Known with certainty from 2 collections from the type locality (the second is BRASS 10934, from 2800 m); a specimen collected by C. B. KLOSS on the Carstensz Mts at 2135 m may also represent this species.

**28. *Plesioneuron stenura*** HOLTUM, *sp. nov.*

*P. crasso affinis*, differt: pinnis 18-jugatis, usque  $23 \times 3$  cm metientibus, lobis omnibus acutis, lobis basiscopicis valde falcatis, lobo infimo acroscopico pinnarum mediarum usque 2.5 cm elongato, lobis inferioribus utroque latere pinnarum superiorum redactis; sporangiis glanduliferis, receptaculo sori pilis acicularibus multis praedito. — Type: L. E. CHEESMAN 152, S.E. New Guinea, Mafulu, 1220 m (K).

*Caudex* not known; *stipe* glabrous, incomplete, probably 40 cm long, basal scales not seen.

*Lamina* c. 70 cm long; pinnae 18 pairs, very firm; apex of frond widened at base and grading to upper pinnae; basal pinnae almost sessile with basal acroscopic lobe elongate and basiscopic lobe a little reduced, both lobes reduced on upper pinnae; aerophores slender, 1 mm long. *Suprabasal pinnae* to 23 cm long, 3 cm wide above the base, basal acroscopic lobe elongate (maximum 2.5 cm) and parallel to rachis, basal basiscopic lobe strongly falcate, 1.2 cm long; apex acuminate with narrow cauda 4–5 cm long; edges lobed to 1.5 mm from costa; acroscopic lobes straight, to 1.8 cm long, basiscopic lobes all strongly falcate and shorter; costules 4.5–5 mm apart; veins to 23 pairs on acroscopic lobes, slender, concolorous and slightly prominent both sides, basal acroscopic vein ending beside or near the sinus-membrane; lower surface quite glabrous; upper surface of rachis almost glabrous, of costae copiously hairy on edges of groove, hairs 0.2 mm long. *Sori* close to costules; abundant acicular hairs present on receptacle with sporangia; indusia firm, dark, glabrous; sporangia bearing several red-orange glands.

Distr. *Malesia*: Papua New Guinea. Known only from the type collection and a small sterile frond from the same locality.

Note. This species is also close to *P. attenuatum* but has sessile basal pinnae and quite glabrous lower surface; scales are needed for a good comparison, those of *P. attenuatum* being very distinctive.

**29. *Plesioneuron ophiura* (COPEL.) HOLTUM**, *Blumea* 22 (1975) 248. — *Dryopteris ophiura* COPEL. Univ. Cal. Publ. Bot. 18 (1942) 220. — *Lastrea ophiura* COPEL. Gen. Fil. (1947) 139; Philip. J. Sci. 78 (1951) 434, pl. 22. — *Thelypteris ophiura* (COPEL.) REED, *Phytologia* 17 (1968) 298. — Type: BRASS 12471, W. New Guinea, Idenburg River, 2050 m, on open rock-slide (MICH; BO, L).

Description of the type: *Caudex* erect, apical scales  $5 \times 1.5$  mm, acute, rigid, copiously short-hairy; *stipe* 16 cm long, minutely hairy. *Lamina* 20 cm long, very firm; pinnae 7–9 pairs; basal pinnae with stalks 2 mm long, basal lobes 1–2 mm long; basal lobes of all other pinnae reduced; apex of frond not pinna-like. *Largest pinna*  $8 \times 1.4$  cm; aerophores slightly swollen; apex acuminate with a cauda 1.5–2.0 cm long; edges lobed to less than 1 mm from costa; lobes slightly falcate on both sides of the costa; costules 3.5–4 mm apart; veins to 10 pairs, immersed (slightly prominent on the lower surface), basal ones both passing to margin above base of sinus; lower surface of rachis bearing copious short pale stiff hairs, similar hairs less copious on costae, also narrow scales, sparse hairs on costules and veins; upper surface glabrous apart from costa. *Sori* near costules; indusia thick, dark, glabrous; sporangia not setiferous, no glands

seen on them; spores dark, minutely papillose.

Distr. *Malesia*: West New Guinea, at 2050 m.

Notes. BRASS 12465, from the same locality as the type but "in young forest at foot of rock-slide, a clump of fern with fronds to 180 cm long" (specimen at L) was named *Lastrea costulisor* by COPELAND, and so accepted by me in 1975, but agrees with the type of *P. ophiura* in deeply lobed pinnae, and probably represents the fully developed form of the same species; its description follows. *Stipe* 100 cm long; basal scales  $10 \times 1.5$  mm. *Lamina* 100 cm long; pinnae 22 pairs, lower ones 7 cm apart; basal pinnae with stalks 3 mm long and 3–4 pairs of basal lobes gradually reduced and separately adnate to costa; all upper pinnae with much-reduced basal lobes; aerophores black, firm, more than 0.5 mm long. *Largest pinnae*  $24 \times 2.5$ –3.0 cm, at base lobed almost to costa, distally to 1 mm from costa, apex with cauda 3 cm long; lobes on acroscopic side of pinna straight, on basiscopic side somewhat falcate; costules 6 mm apart; veins to 20 pairs; sporangia sometimes with a small shrivelled gland, rarely a short seta. If this is included in *P. costulisorum*, I think that the type of *P. ophiura* should also be so included.

**30. *Plesioneuron costulisorum* (COPEL.) HOLTUM**, *Blumea* 22 (1975) 246. — *Dryopteris basisora* COPEL. Philip. J. Sci. 6 (1911) Bot. 73, non CHRIST 1909. — *Lastrea costulisor* COPEL. Gen. Fil. (1947) 138, nom. nov. — *Thelypteris costulisor* (COPEL.) REED, *Phytologia* 17 (1968) 269. — Type: C. KING 304, E. New Guinea (MICH, BO, BRI, NSW).

*Caudex* lacking on type; *stipe* incomplete, glabrescent. *Lamina* 60 cm or more long; pinnae 15–20 pairs; basal pinnae with stalks to 2 mm long, basal 2 pairs of lobes gradually reduced; aerophores not elongate. *Largest pinnae*  $22 \times 3$  cm; apex acuminate; edges lobed to 1–1.5 mm from costa; lobes on acroscopic side of costa straight, on basiscopic side somewhat falcate; costules 5 mm apart; veins commonly 18–20 pairs, basal acroscopic vein ending beside or near sinus-membrane; lower surface of rachis and costae bearing coarse erect brown hairs, hairs on costules similar but shorter, very short hairs present on and between veins, a few narrow fringed scales present on costae; upper surface of costae densely brown-hairy throughout, rest of surface glabrous. *Sori* near costules; indusia dark, firm, with a few short hairs; acicular hairs present on receptacle of sorus with the sporangia; sporangia bearing an orange gland; spores of type not seen.

Distr. *Malesia*: Eastern New Guinea, in forest, at altitudes to 1000 m.

Note. Other specimens which agree in frond-form and *sori* have differences in pubescence. PULLEN 8417 from 250 m in Milne Bay District differs in sparse shorter hairs on the lower surface

of rachis and costae and lacks hairs between veins. CROFT & LELEAN 68533, from a low altitude near the coast 93 km S.E. of Lae, has slender pale hairs 1 mm long on the lower surface of costules and many short hairs between veins. See also note above on *P. ophiura*.

**31. *Plesioneuron doctersii* HOLTUM**, *Blumea* 22 (1975) 246. — Type: DOCTERS VAN LEEUWEN 10357, W. New Guinea, Rouffaer River, 300 m (BO; L).

*Caudex* short-creeping, 1.5 cm diameter; *stipe* 25–40 cm long, glabrescent, basal scales rather thin, apparently c.  $3 \times 1$  mm. *Lamina* 40–50 cm long, thick and rigid when dry; pinnae 15–18 pairs; basal pinnae with stalks 3 mm long, only 1 pair of basal lobes reduced; successive pinnae with shorter stalks, only distal ones sessile; apex of frond not pinna-like. *Largest pinnae* 9–11 cm long, 2.2–2.6 cm wide; apex short-acuminate; edges lobed to 1.5–2.5 mm from costa; lobes separated by narrow sinuses, basiscopic lobes more falcate and shorter than acroscopic lobes; costules 4.5–5 mm apart; veins to 15 pairs, little prominent on either side, basal pair both passing to sides of the sinus-membrane; *lower surface* of rachis bearing rather dense stiff erect hairs 0.1–0.2 mm long, sparse longer hairs present on costae, costules, sinus-membranes and margins; *upper surface* of costae covered with thick antrorse hairs 0.2–0.3 mm long, minute hairs on costules. *Sori* near costules; indusia dark, thick, with a few hairs; sporangia sometimes bearing a small gland or a seta; spores not seen.

Distr. *Malesia*: W. New Guinea, type locality and Japen Island (L. E. CHEESMAN 1430).

Note. Specimens from Japen Island have some setiferous sporangia, those from type locality only glands.

**32. *Plesioneuron rigidilobum* HOLTUM**, *Blumea* 22 (1975) 248. — Type: T. G. WALKER 7741, N.E. New Guinea, Edie Creek above Wau, on gold-mining rubble (BM).

*Caudex* suberect; *stipe* to 75 cm long, basal scales 5–6 mm long, narrow, thick. *Lamina* to 60 cm long, thick and rigid; pinnae 18 pairs; basal pinnae with stalks 2 mm long and free basal acroscopic lobes 8 mm long, basal basiscopic lobes shorter, several pairs of successive pinnae also stalked; basal lobes of middle and upper pinnae not reduced; apex of frond almost pinna-like. *Largest pinnae* of type  $14 \times 2.5$  cm; apex acuminate, not or little caudate; edges lobed to 1 mm from costa or more deeply; lobes on acroscopic side straight and nearly at right angles to costa, on basiscopic side slightly falcate and a little shorter; costules 4.5–5 mm apart; veins to 15 pairs, basal veins both passing to margin above base of sinus; *lower surface* of rachis and costae bearing short pale hairs and thicker brown ones to

0.5 mm long, hairs on costules fewer, not brown, somewhat antrorse, a few very short hairs present on veins and on surface between them; *upper surface* of rachis and costae bearing many short hairs. *Sori* medial or somewhat inframedial, not touching costules; indusia large, firm, short-hairy; sporangia bearing small glands and rarely a seta; spores dark, minutely spinulose.

Distr. *Malesia*: Eastern New Guinea at 2000–2500 m.

Note. It is possible that this is connected by intermediates with *P. ophiura* and *P. costulisorum*.

**33. *Plesioneuron wantotense* (COPEL.) HOLTUM**, *Blumea* 22 (1975) 245. — *Dryopteris wantotensis* COPEL. Univ. Cal. Publ. Bot. 18 (1942) 220. — *Lastrea wantotensis* COPEL. Gen. Fil. (1947) 140; Philip. J. Sci. 78 (1951) 436, pl. 24. — *Thelypteris wantotensis* (COPEL.) REED, *Phytologia* 17 (1968) 324. — Type: CLEMENS 11013 bis, N.E. New Guinea, Morobe Distr. 1200 m (MICH).

*Caudex* short, erect; *stipe* to 28 cm long, glabrous above base, basal scales small, acuminate, hairy. *Lamina* to at least 20 cm long; pinnae 10 pairs; basal pinnae sessile with 2 pairs of basal basiscopic lobes reduced, basal one very small; apex of frond pinna-like but broader than pinnae. *Largest complete pinna*  $5.5 \times 1.2$  cm (one incomplete pinna 1.7 cm wide); apex acuminate with cauda 10 mm long; edges lobed to 1.5 mm from costa; lobes on acroscopic side almost straight, on basiscopic side shorter and falcate; costules 3–4 mm apart; veins 10–12 pairs, basal acroscopic one ending beside sinus-membrane; *lower surface* of rachis, costae, costules, sinus-membrane and margins of lobes bearing short stiff erect hairs; *upper surface* of rachis and costae short-hairy, rest glabrous. *Sori* near costules; indusia thick, dark, glabrous; sporangia bearing 2–3 red glands; spores not seen.

Distr. *Malesia*: Papua New Guinea, only known from the type.

Note. Apart from size, the type differs from *P. attenuatum* (which is similar in frond-form) in its much shorter basal stipe-scales.

**34. *Plesioneuron kundipense* HOLTUM**, *Blumea* 22 (1975) 247. — Type: MILLAR & HOLTUM NGF 18593, N.E. New Guinea, Western Highlands, 2150 m (LAE; BRI, K).

*Caudex* short, thick, creeping; *stipe* to 26 cm long, minutely hairy; basal scales thick at base, thin distally, to  $5 \times 1.5$  mm. *Lamina* of type 29 cm long; pinnae 14 pairs; basal pinnae with stalks not over 1 mm long, aerophores slightly elongate, 1 pair basal lobes slightly reduced; apex of frond not pinna-like. *Largest pinnae*  $8.5 \times 2.0$  cm; apex acuminate with short cauda; edges lobed to 1 mm from costa; lobes slightly falcate on both sides of costa; costules 3.5–4 mm apart; veins to 12 pairs,

prominent both sides, basal acroscopic one ending near sinus-membrane; lower surface of rachis and costae rather densely covered with stiff erect hairs 0.3–0.4 mm long, fewer hairs on costules, a few on veins, rarely between veins; upper surface of rachis and costae hairy as lower surface, scattered shorter hairs present on surface between veins. *Sori* medial or a little inframedial; indusia firm, dark, with a variable number of very short hairs; some sporangia bearing a short seta, glands not seen; short acicular hairs present on receptacle or on stalks of sporangia; spores not seen.

Distr. *Malesia*: Papua New Guinea (Western Highlands, 2150 m). Known only from the type.

**35. *Plesioneuron dryas* HOLTUM**, *Blumea* 22 (1975) 247. — Type: BRASS 23447, Eastern New Guinea, Milne Bay Distr., Mt Dayman, in oak forest 800 m (BM; L, LAE).

*Caudex* short, horizontal (*teste* BRASS); *stipe* to 60 cm long, glabrescent, basal scales c.  $10 \times 1$  mm, rigid, covered with short hairs, scales above base thinner. *Lamina* 50 cm long; pinnae 12 pairs, several lower pairs opposite; basal pinnae with stalks to 1 mm long, basal acroscopic lobe free and only slightly reduced, 3–4 pairs of basicopic lobes gradually reduced; basal lobes not reduced on upper pinnae; apex of frond widened at base with transition to pinnae. *Largest pinnae*  $12 \times 2$  cm on type ( $14 \times 2.5$  cm on BRASS 28451); aerophores slightly elongate; apex short-acuminate with entire cauda 10–15 mm long; edges lobed to 1–1.5 mm from costa; lobes slightly falcate, those on basicopic side somewhat more oblique than those on acroscopic side; costules 3.5–4.5 mm apart; veins 10–12 pairs, slender and prominent both sides, basal acroscopic veins usually passing to margin just above base of sinus; lower surface of rachis and costae rather densely covered with short erect hairs, sometimes with scattered longer brown ones, sparse hairs on costules and veins and between veins; upper surface of costae densely short-hairy, sparse hairs on costules. *Sori* a little inframedial; indusia dark, firm, with a few short hairs; sporangia bearing red glands, sometimes several; spores not seen.

Distr. *Malesia*: Eastern New Guinea (2 collections) and Rossel Island.

**36. *Plesioneuron croftii* HOLTUM**, *sp. nov.*

*Stipes* usque 36 cm longus, basi paleis brevibus vestitus; lamina 23 cm longa; pinnae 5-jugatae, suboppositae; pinnae infimae sessiles, aerophoris tenuibus pallidis 1 mm longis praeditae, lobis infimis vix redactis; pinnae maximae  $12.5 \times 2.5$  cm, lobis vix falcatis utroque latere fere aequalibus; venae 12–14-jugatae; sori prope costulas siti; indusia pilis 0.3 mm longis vestita; sporangia glandulis pallidis praedita. — Type: J. R. CROFT 413, E. New Guinea, Natter Bay, 93 km S.E. of Lae, 50 m alt. (K; NSW).

*Caudex* short-creeping; *stipe* to 36 cm long, pale, sparsely short-hairy, basal scales not well preserved, short and relatively broad at base, thinner above base. *Lamina* 23 cm long; pinnae 5 pairs, subopposite; aerophores pale, slender, hairy, to 1 mm long; apex of frond pinna-like, 11 cm long; basal lobes of basal pinnae hardly reduced, acroscopic lobe not elongate; basal basicopic lobes of distal pinnae reduced. *Largest pinnae*  $12.5 \times 2.5$  cm (on another frond  $10.5 \times 1.5$  cm); apex acuminate with cauda to 15 mm long; edges lobed to 1–1.5 mm from costa, lobes almost equal on the two sides of the costa, somewhat oblique, slightly falcate; costules 3–3.5 mm apart; veins 12–14 pairs, slightly prominent both sides, basal ones usually both passing to margin above base of sinus; lower surface of rachis bearing stiff erect hairs 0.2–0.5 mm long, similar hairs on costae to 0.8 mm, fewer hairs on costules, slender erect hairs on surface between veins; upper surface of rachis and costae hairy as lower surface but hairs thicker, no other hairs. *Sori* near costules; no acicular hairs on receptacle; indusia medium brown, firm, not very thick, with many hairs 0.3 mm long; sporangia not setiferous, sometimes bearing small inconspicuous pale glands; spores dark, minutely spinulose.

Distr. *Malesia*: Papua New Guinea; only known from the type.

Note. The type was growing near larger plants which are mentioned above under *P. costulisorum*. It seems probable that *P. croftii* produces only small plants; more information is needed. Apart from size, it differs from the larger plants in the presence of slender pale aerophores of a kind I have not seen on other plants of this genus.

#### 14. CYCLOGRAMMA

TAGAWA, *Acta Phytotax. Geobot.* 7 (1938) 52; CHING, *Acta Phytotax. Sinica* 8 (1963) 316; HOLTUM, *Blumea* 19 (1971) 28. — *Glaphyopteris* sect. *Cyclogramma* H. ITO in Nakai & Honda, *Nov. Fl. Jap. n. 4* (1939) 148. — *Thelypteris* subg. *Cyclogramma* K. IWATS. *Mem. Coll. Sci. Univ. Kyoto B*, 31 (1964) 26. — **Fig. 10a–c.**

*Caudex* short to long-creeping; scales on stipe-base bearing acicular hairs, sometimes hooked; fronds drying dark-olivaceous, bearing short



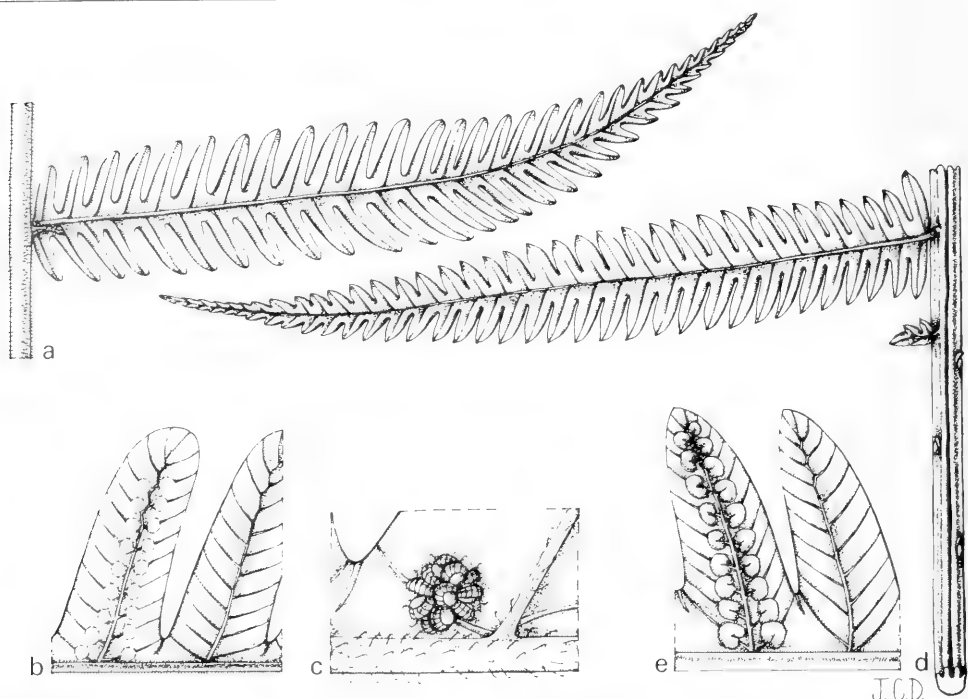


Fig. 10. *Cyclogramma auriculata* (J. SM.) CHING. a. Middle pinna, with an aerophore,  $\times 1$ ; b. venation, sinus-membrane and sori,  $\times 3$ ; c. sorus showing hooked hairs,  $\times 9$ . — *Pseudocyclosorus tyloides* (KUNZE) CHING. d. Basal normal pinna and reduced pinnae,  $\times 1$ ; e. two pinna-lobes showing venation and sori,  $\times 4$  (a–c JACOBS 7299, d–e PRICE 387).

hooked hairs on lower surface of all axes and usually also on sporangia; lower pinnae reduced or not; aerophores at bases of pinnae swollen or elongate; pinnae deeply lobed; veins spreading at a wide angle to costule, basal ones from adjacent costules running to edge close to, or just above, sinus-membrane, never united; sori exindusiate; no glandular hairs on stalks of sporangia; spores pale with translucent anastomosing wings.

Type species: *Cyclogramma simulans* (CHING) TAGAWA.

Distr. About 8 spp., Northern India to S. China, Taiwan; in Malesia: Philippines (Luzon).

Cytol. Base chromosome number probably 36: *C. auriculata* tetraploid; *C. omeiensis* octoploid ( $n = c. 136$ ; KURITA, J. Jap. Bot. 41, 1966, 176).

Note. A very distinct genus which has no obvious near allies. The species *C. auriculata* is one of several ferns which are mainly distributed in Mainland Asia but have established themselves in Northern Luzon.

1. *Cyclogramma auriculata* (J. SM.) CHING, Acta Phytotax. Sinica 8 (1963) 317; HOLTUM, Kalikasan 5 (1976) 110. — *Polypodium subvillosum* MOORE, Ind. Fil. (1861) 308, *nom. nud.* — *Polypodium auriculatum* WALL. ex HOOK. Spec. Fil. 4 (1862) 237, *non* LINN., *nec* RADDI, *nec* PRESL; BEDD. Ferns Br. India (1866) t. 203; CLARKE, Trans. Linn. Soc. Bot. 1 (1880) 543. — *Phegopteris auriculata* J. SM. Hist. Fil. (1875) 233, *nom. nov.*;

BEDD. Handb. (1883) 290, f. 149, *excl. syn.* *Polypodium appendiculatum* BEDD. — *Dryopteris auriculata* (J. SM.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 2 (1931) 196. — *Dryopteris himalayensis* C. CHR. Ind. Fil. Suppl. III (1934) 88, *nom. nov. superfl.* — *Thelypteris subvillosa* CHING, Bull. Fan Mem. Inst. Biol. Bot. 6 (1936) 279. — *C. himalayensis* TAGAWA, Acta Phytotax. Geobot. 7 (1938) 55. — *Thelypteris auriculata* (J. SM.) K.



IWATS. Acta Phytotax. Geobot. 19 (1961) 11; Mem. Coll. Sci. Univ. Kyoto B, 31 (1965) 42. — Type: WALLICH 314, Nepal (K).

*Thelypteris simulans* CHING, Bull. Fan Mem. Inst. Biol. Bot. 6 (1936) 280. — Type: FAURIE s.n. May 1914, Taiwan, Mt Arisan (S-PA).

*Dryopteris squamaestipes* sensu HAYATA, Icon. Fl. Formosa 4 (1914) 179, f. 117, not *Polypodium appendiculatum* BEDD. var. *squamaestipes* CLARKE. — Fig. 10a–c.

Caudex erect, to c. 10 cm tall. Stipe 5–10 cm long, densely covered with short pale hooked hairs, at base broad brown scales with some hooked hairs on them. Lamina to 100 cm long; pinnae more than 30 pairs, lower 10 pairs gradually reduced, a subabrupt transition between the upper of these and largest pinnae, lowest pinnae 3–4 mm long; aerophores at bases of pinnae 2 mm

long. Largest pinnae seen on Philippine plants 10 × 2 cm (on Indian and Chinese plants to 20 × 2.5 cm), lobed to 1–1.5 mm from costa, base truncate, apex acuminate; lobes oblique, oblong with rounded tips, entire; costules 5–7 mm apart; veins to 11 pairs; hairs on lower surface of rachis 1 mm long, hooked, shorter hooked hairs on costae and costules, marginal hairs not hooked; hairs on upper surface of costae 1 mm long, not hooked; short suberect hairs between veins, a few of them hooked. Sori near costules; sporangia usually with 1 hooked hair.

Distr. N. India to S. China & Taiwan, in Malesia: Philippines (N. Luzon; Mt Pulog, M. JACOBS 7299 in L.K.).

Ecol. Moist gully in mossy forest at 2600–2700 m altitude.

## 15. PSEUDOCYCLOSORUS

CHING, Acta Phytotax. Sinica 8 (1963) 322, excl. *P. ciliatus* (BENTH.) CHING and *P. caudipinna* CHING; HOLTUM, J. S. Afr. Bot. 40 (1974) 137. — *Pneumatopteris* sensu HOLTUM, Blumea 19 (1971) 42, p.p. — Fig. 10d–e.

Caudex erect or short-creeping; scales broad, thin, bearing when young marginal mucilage-secreting hairs; stipe scaly near base as caudex, scales appressed. Fronds bearing many deeply-lobed pinnae, at base an abrupt transition to much smaller ones; aerophores always swollen, in the sole Malesian species elongate; veins free, basal acroscopic vein to base or side of sinus-membrane, basal basisopic vein to edge above base of sinus; short capitate hairs often present on lower surfaces or on indusia, spherical sessile glands lacking. Sori indusiate; no glands nor setae on sporangia; on sporangium-stalk a hair of 2–3 cells, terminal cell largest but not spherical; spores bearing many small subequal wings.

Type species: *Pseudocyclosorus tylodes* (KUNZE) CHING (by error as *xyloides*).

Distr. About 11 spp. Tropical Africa, Madagascar, Mascarene Islands, S. India & Ceylon, N. India to Japan; in Malesia: Philippines (Luzon).

Cytol. Chromosome numbers 35 and 36 both reported. *P. tylodes*, diploid (36, Ceylon and N. India); *P. esquirolii* and *P. repens*, both diploid (35, N. & S. India); *P. ochthodes*, diploid (35 and 36 both reported from India). There are erroneous records in LÖVE, LÖVE & PICHI SERMOLLI, Cytotaxonomical Atlas of Pteridophyta, p. 221.

Notes. This genus differs from *Pneumatopteris* in having veins always free, lamina never pustular when dry, sporangia lacking glands or setae on body. Because of the position of basal veins in relation to the sinus-membrane CHING (1963) thought *Dryopteris patens* (SW.) O. KTZE and *D. normalis* (SOD.) C. CHR. of Tropical America should probably be included in *Pseudocyclosorus*, but in my judgement these species, and some others allied to them in Africa, are better regarded as constituting a section of *Christella* (see HOLTUM, J. S. Afr. Bot. 40, 1974, 144). CLARKE (1880) united all species of *Pseudocyclosorus* in N. India under the name *Nephrodium prolixum*, based on *Aspidium prolixum* WILLD., but WILLDENOW's type is a species of *Christella* from New Caledonia (HOLTUM, Amer. Fern J. 63, 1973, 82).

1. *Pseudocyclosorus tylodes* (KUNZE) CHING, Acta Phytotax. Sinica 8 (1963) 324; HOLTUM, Brit. Fern Gaz. 11 (1974) 55; HOLTUM & GRIMES,

Kew Bull. 34 (1979) 503. — *Aspidium tylodes* KUNZE, Linnaea 24 (1851) 244, 283 (*xyloides*, err. typ., p. 281). — *Lastrea tylodes* (KUNZE) MOORE,

Ind. Fil. (1858) 107; BEDD. Ferns S. India (1863) t. 107; COPEL. Fern Fl. Philip. (1960) 330. — *Nephrodium ochthodes* var. *tylodes* BEDD. Handb. (1883) 240. — *Nephrodium tylodes* (KUNZE) HOPE, J. Bombay Nat. Hist. Soc. 14 (1903) 724. — *Dryopteris tylodes* (KUNZE) CHRIST, Notul. Syst. 1 (1909) 41; C. CHR. Contr. U. S. Nat. Herb. 26 (1931) 274. — *Thelypteris tylodes* (KUNZE) CHING, Bull. Fan Mem. Inst. Biol. Bot. 6 (1936) 296; HENNIPMAN, Blumea 16 (1968) 99, f. 1e. — Syntypes cited: SCHMID-KOCH 11, 63, 89, 115, Nilgiri Hills, S. India (none seen).

*Dryopteris crassinervia* C. CHR. Hedwigia 74 (1934) 229. — Type: G. STEIN 1179, Timor, Ramelau (B; BM).

*Nephrodium prolixum sensu* BAK. Syn. Fil. (1867) 268, var. *tylodes tantum*. — *Dryopteris luerssenii* (non HARR.) CHRIST, Philip. J. Sci. 2 (1907) Bot. 208. — Fig. 10d-e.

Caudex erect. Stipe short, glabrous, flushed red, covered at base with broad scales. Reduced pinnae many pairs, represented by aerophores only. Lamina 30–80 cm long, subcoriaceous, rigid when dry; basal pinnae narrowed towards their bases; aerophores elongate. Largest pinnae 12–20 × 1.2–2.0 cm; base subtruncate with basal acroscopic lobe ± elongate; apex caudate-acuminate; edges lobed to 1.5–2 mm from costa, lobes entire with

falcate acute tips; costules 3.5–4.5 mm apart; veins 10–12 pairs, pale and prominent on both surfaces; lower surface entirely glabrous or some acicular hairs present on distal parts of costae and on sinus-membranes; upper surface hairy only on costa. Sori inframedial; indusia large, firm, glabrous; spores dark, finely spinulose.

Distr. India (except N.W.) and Ceylon, Burma to S.W. China and Hong Kong; in Malesia: Philippines (N. Luzon) and Lesser Sunda Is. (Timor). For a similar distribution, see VAN STEENIS, J. Linn. Soc. Bot. 79 (1979) 127.

Ecol. In Luzon at 1700–2500 m, usually on banks of streams.

Notes. It is evident from KUNZE's preliminary list of species (l.c. 1851, p. 244) that he intended the specific epithet to be *tylodes* (from the Greek *tylos*, meaning a hump or knob, referring to the aerophores); the name is also so written in the description of *Aspidium ochthodes* where the two species are compared. METTENIUS, HOOKER and BEDDOME all adopted this spelling. It seems to me certain that the spelling *xyloides* on p. 281 was an error; it has no meaning. The paper was published shortly after the death of KUNZE, who perhaps did not correct a proof. I regard the use of *xyloides* by later authors as an error, to be corrected.

## 16. PNEUMATOPTERIS

NAKAI, Bot. Mag. Tokyo 47 (1933) 179; HOLTUM, Blumea 19 (1973) 42, excl. *Pseudocyclosorus* CHING; Allertonia 1 (1977) 226. — *Thelypteris* subg. *Pneumatopteris* K. IWATS. Mem. Coll. Sci. Univ. Kyoto B, 31 (1964) 33, excl. sect. *Macrocyclusorus*. — *Cyclosorus sensu* CHING, Bull. Fan Mem. Inst. Biol. Bot. 8 (1938) 230, p.p.; sensu HOLTUM, Rev. Fl. Mal. 2 (1955) 255, p.p.; *Lastrea et Cyclosorus sensu* COPEL. Gen. Fil. (1947) 135, 140, p.p. — Fig. 11.

Caudex usually short, erect or decumbent, long-creeping in 2 spp.; stipe never conspicuously hairy, basal scales in almost all cases broad, thin, bearing few marginal acicular hairs, in some species also septate hairs bearing mucilage-cells; fronds usually large with many pinnae, and in almost all species a varied number of much-reduced basal pinnae, the transition to these gradual or abrupt; lamina of reduced pinnae in most species distinct, in the type and a few others greatly reduced; aerophores at bases of reduced and lower normal pinnae ± swollen, in a few cases much elongate and then small aerophores also present at bases of costules; pinnae always lobed, edges of lobes distinctly cartilaginous and in some species toothed at the ends of veins; veins free in a few species which have deeply lobed pinnae, in most species the basal veins at least anastomosing (in *P. costata* small plants with fertile fronds may have free veins, later and larger fronds having anastomosis); lamina between veins almost always ± pustular when dried (*P. costata* is an exception); lower surface of rachis, costae and

other parts never densely hairy, short capitate hairs present in some species, minute colourless glands in a few, conspicuous sessile spherical glands never present; sori usually covered with rather thin indusia; sporangia often bearing short club-shaped glandular hairs (rarely setae) near annulus and on the stalk a hair of 3–4 cells, the terminal cell enlarged but usually colourless; spores in most cases light brown, bearing many very small  $\pm$  quadrate wings, in a few species a  $\pm$  continuous longitudinal wing with cross-wings.

Type species: *Pneumatopteris callosa* (BL.) NAKAI.

Distr. Tropics of the Old World, in the Pacific southwards to New Zealand; in all c. 80 spp., the majority Malesian.

Ecol. Almost all species in forest, especially near streams, some in rocky stream-beds; a few species confined to limestone.

Cytol. Base chromosome number 36; 7 Malesian spp., including *P. costata*, diploid (T. G. WALKER, unpublished); *P. truncata* tetraploid in Ceylon and diploid in N. India and Sarawak; *P. pennigera* (G. FORST.) HOLTUM tetraploid in New Zealand.

Taxon. NAKAI confined the genus to one species, stating "there is no other fern with which it can offer any specific comparison", but there are three species closely allied to the type in Malesia and four more in the Pacific. The distinctive character of this group is the extreme reduction of basal rudimentary pinnae which consist of little more than swollen aerophores which project through the layer of mucilage which covers very young fronds (GOEBEL, Ann. Jard. Bot. Btzig 36, 1926, 84–96, with figures). TROLL described the mucilage-bearing scales of another species (probably *P. kerintjiensis*) which he mis-named *Dryopteris sumatrana* v. A.v.R. (Flora 128, 1933, 329–337); this species has shorter aerophores than *P. callosa* and quite large reduced basal pinnae. The number, shape and size of such pinnae provide important characters for distinguishing between species, and in some cases there is still not enough information about them.

*Pneumatopteris* is closely related to *Sphaerostephanos* but is distinct in the following characters: presence of colourless short capitate hairs in place of spherical sessile glands; limited development of acicular hairs apart from adaxial surface of rachis and costae; pustular appearance of lower surface between veins of dried fronds; broad thin stipe-scales. There are exceptions to some of these, the most notable in Malesia being *P. costata* and a few allies which do not have a pustular surface when dried. The species with free veins are nearly all in New Guinea. They do not look like a primitive group and may be derived from ancestors with anastomosing veins. *P. truncata* looks more like a prototype for the genus.

#### KEY TO THE SPECIES

1. Veins anastomosing.
  2. Stipe and rachis bearing many dark spines 1 mm long irregularly arranged.
    3. Indusia lacking.
      4. Pinnae to 25  $\times$  1.6–2.7 cm with cauda 3 cm long; spores with many small wings . . . . . 1. *P. glabra*
      4. Pinnae to 12  $\times$  2 cm with cauda 1.5 cm; spores with wing and cross-wings . . . . . 2. *P. sibelana*
    3. Indusia present.
      5. Pinnae short-acuminate (Sumatra) . . . . . 3. *P. dicranogramma*
      5. Pinnae narrowly long-acuminate (Philippines) . . . . . 1. *P. glabra*
  2. Stipe and rachis lacking such spines.
    6. Elongate aerophores present at bases of pinnae.
      7. Reduced pinnae consisting of a prominent aerophore with a minute rim . . . . . 4. *P. callosa*
      7. Reduced pinnae with a distinct lamina.
        8. Pinnae crenate; veins 6–7 pairs . . . . . 5. *P. subappendiculata*
        8. Pinnae lobed 1/3 towards costa; veins 10–16 pairs . . . . . 6. *P. superba*
    6. Aerophores not elongate (in many cases slightly swollen).
      9. Indusia lacking.
        10. Pinnae commonly 12–15  $\times$  1.5–2.0 cm, thin; lower surface of rachis with or without minute acicular hairs; sporangia with capitate hairs . . . . . 7. *P. costata*
        10. Pinnae to 7  $\times$  1 cm, rigid when dry; lower surface of rachis densely covered with erect hairs 0.3 mm long; sporangia mostly bearing setae . . . . . 8. *P. latissquamata*
      9. Indusia present.

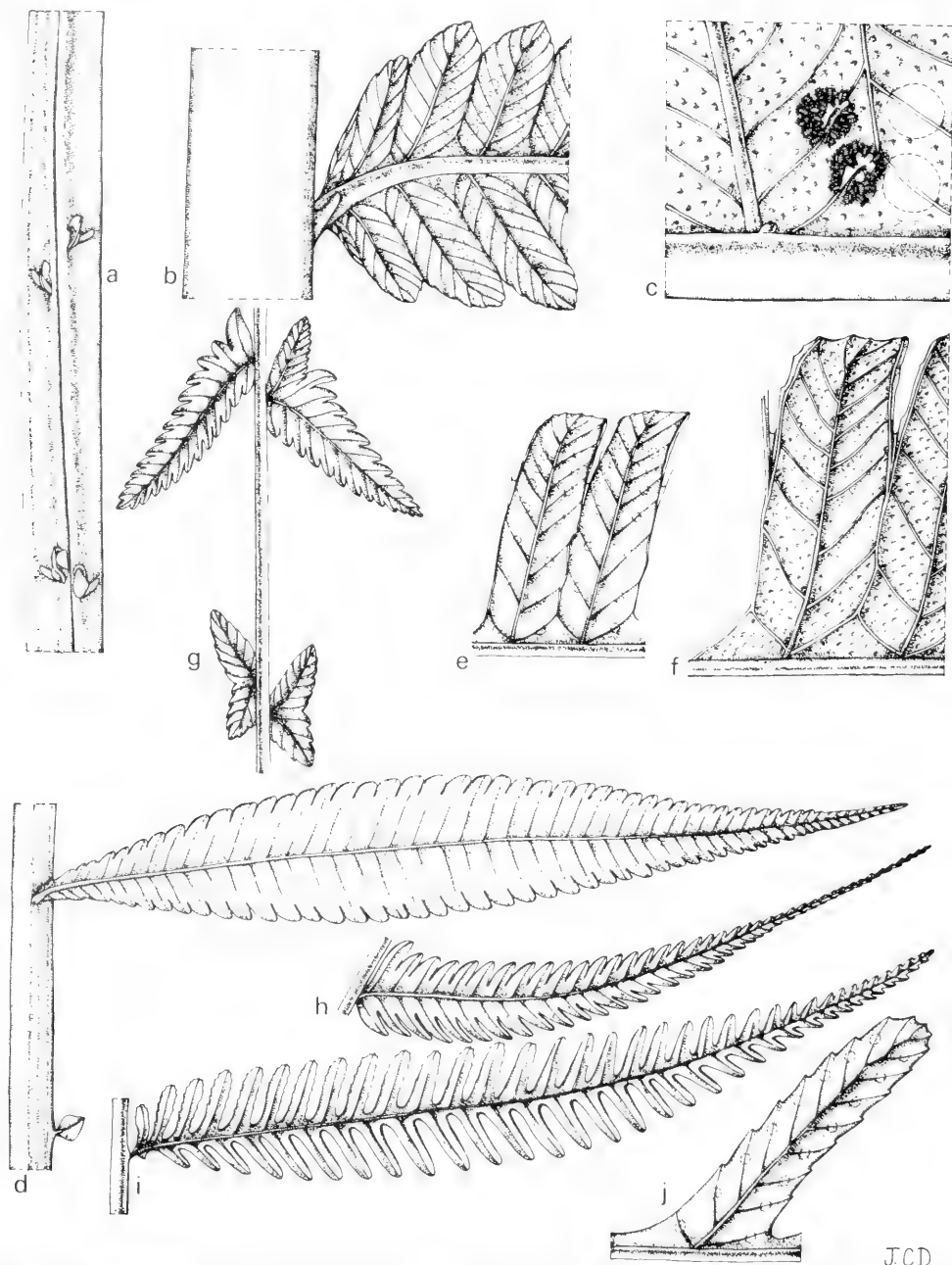


Fig. 11. *Pneumatopteris callosa* (BL.) NAKAI. a. Reduced basal pinnae,  $\times 1$ ; b. base of normal pinna,  $\times 2$ ; c. part of a fertile pinna showing pustular lamina, aerophore at base of costule and sori,  $\times 8$ . — *P. truncata* (POIR.) HOLTUM. d. Basal normal pinna and a reduced pinna,  $\times \frac{1}{2}$ ; e. part of pinna,  $\times 2$ ; f. showing veins joined along margin in lobes,  $\times 3$ . — *P. laevis* (METT.) HOLTUM. g. Reduced basal pinnae,  $\times 1.5$ ; h. upper pinna,  $\times \frac{1}{2}$ . — *P. keysseriana* (ROSENST.) HOLTUM. i. Basal pinna,  $\times \frac{1}{2}$ ; j. one pinna-lobe,  $\times 3$  (a–c W. L. CHEW *et al.* 1373, d–f MATTHEW *s.n.*, g–h MATTHEW *s.n.*, i–j cult. Kew).

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11. Veins in fertile pinnae 2-5 pairs; pinnae in most cases not over 12 cm long.
12. Lower pinnae gradually reduced; stipe 5-15 cm long.
  13. Basal pinnae auricled on acroscopic base.
    14. Basal large pinnae narrowly cuneate at base on basiscopical side . . . . . 9. *P. egenolfioides*
    14. Basal pinnae truncate at base on basiscopical side.
      15. Brown hairs on rachis both sides; pinnae to 8 cm long . . . . . 10. *P. patentipinna*
      15. Lower surface of rachis glabrous; pinnae 3-3.5 cm long.
        16. Pinnae lobed 2/5-1/2 towards costa . . . . . 11. *P. cheesmaniae*
        16. Pinnae crenate . . . . . 12. *P. lithophila*
  13. Basal pinnae not auricled on acroscopic base.
    17. Basal pinnae narrowly cuneate on basiscopical side; pinnae to 15 cm long including cauda 4-5 cm . . . . . 13. *P. angusticaudata*
    17. Basal pinnae not so; pinnae, if 15 cm long, with shorter cauda . . . . . 14. *P. microloncha*
12. Abrupt transition to reduced pinnae; stipe 20 to 50 cm long . . . . . 15. *P. brooksii*
11. Veins in fertile pinnae 7-10 pairs or more; pinnae usually much longer.
  18. Basal pinnae not or variably a little reduced.
    19. Pinnae 4 cm or more wide, lobed less than 1/2 . . . . . 16. *P. inclusa*
    19. Pinnae to 2.5 cm wide, lobed more than 1/2 . . . . . 17. *P. longipes*
  18. At least 1 pair basal pinnae conspicuously reduced.
    20. Middle and upper pinnae very oblique, their bases asymmetric; apices of pinnae long and very narrow.
      21. Largest reduced pinnae and lower normal ones distinctly auricled at their bases . . . . . 18. *P. laevis*
      21. Lower pinnae narrowed towards their bases and not auricled.
        22. Pinnae lobed 1/2 way to costa; c. 12 pairs of reduced pinnae, largest 3 cm long . . . . . 19. *P. obliqua*
        22. Pinnae lobed less deeply; reduced pinnae c. 6 pairs, largest 5 mm long . . . . . 13. *P. angusticaudata*
20. Middle pinnae not very oblique, their bases  $\pm$  symmetrical.
  23. One pair basal pinnae reduced.
    24. Reduced pinnae 2 cm long; normal pinnae lobed more than 1/2 . . . . . 20. *P. basicurtata*
    24. Reduced pinnae 1 mm long; normal pinnae lobed less than 1/2 . . . . . 21. *P. microauriculata*
  23. At least 2 pairs of abruptly reduced pinnae or several pairs gradually reduced.
    25. Reduced pinnae and lower normal pinnae with large serrate or lobed acroscopic auricles.
      26. Reduced pinnae 2-4 pairs, subequal . . . . . 22. *P. ecallosa*
      26. Reduced pinnae to 8 pairs, decreasing downwards . . . . . 23. *P. auctipinna*
    25. Reduced pinnae and lower normal pinnae not thus auricled.
      27. Hairs on upper surface of rachis thick, brown; some similar hairs usually present on lower surface of rachis and costae.
        28. Pinnae lobed less than 1/2; 1 1/2 pairs of veins anastomosing . . . . . 24. *P. jermyi*
        28. Pinnae lobed 1/2-2/3; basal veins meeting at base of sinus-membrane . . . . . 25. *P. papuana*
  27. Hairs on rachis and costae not thick and brown.
    29. Lower pinnae gradually decrescent, at least on fertile fronds.
      30. Indusia very small; lower surface bearing minute glands between veins . . . . . 7. *P. costata*
      30. Indusia conspicuous; lower surface lacking such glands . . . . . 26. *P. rodigasiana*
29. Transition from normal to reduced pinnae abrupt.
  31. Pinnae lobed 2/3 or more deeply.
    32. Pinnae lobed to 1.5 mm from costa, not pustular between veins when dried . . . . . 27. *P. japonensis*
    32. Pinnae lobed less deeply, pustular between veins.
      33. Pinna-lobes dentate at ends of veins . . . . . 28. *P. tobaica*
      33. Pinna-lobes entire.
        34. Pinnae lobed to 2.5 mm from costa; hairs present on all parts of lower surface . . . . . 29. *P. incisa*
        34. Pinnae lobed to 4 mm from costa; lower surfaces quite glabrous . . . . . 30. *P. psilophylla*
  31. Pinnae lobed at most 3/5 towards costa.
    35. Lowest pinnae considerably narrowed towards their bases, gradually or rather abruptly.
      36. Pinnae of well-grown plants lobed more than 1/2.
        37. Stipe-scales narrow, spreading . . . . . 31. *P. pergamacea*
        37. Stipe-scales thin, appressed.
          38. Pinnae commonly 2.5-3 cm wide; sporangia lacking glands . . . . . 32. *P. sogerensis*

38. Pinnae not over 2 cm wide; sporangia bearing glands . . . . . 33. *P. micropaleata*  
 36. Pinnae of well-grown plants lobed less than 1/2.  
 39. Pinnae commonly  $20 \times 2.5$  cm, usually with some hairs on lower surface of costae, often also between veins . . . . . 34. *P. truncata*  
 39. Pinnae not more than 2 cm wide; lower surface quite glabrous.  
 40. Pinna-lobes almost at right angles to costa; sporangia bearing glands . . . . . 35. *P. lawakii*  
 40. Pinna-lobes oblique; no glands on sporangia . . . . . 36. *P. michaelis*  
 35. Lowest pinnae not or little narrowed towards their bases.  
 41. Upper reduced pinnae longer than wide, with dilated bases and lobed distally; lower surface slightly pustular . . . . . 37. *P. nitidula*  
 41. Upper reduced pinnae as long as wide, not dilated at base nor lobed above base, strongly pustular between veins . . . . . 38. *P. kerintjiensis*
1. Veins free.  
 42. Largest pinnae less than 2 cm long, entire or slightly crenate; many pairs of lower pinnae gradually decrescent . . . . . 39. *P. nephrolepioides*  
 42. Largest pinnae in most cases larger; lower pinnae otherwise.  
 43. Both surfaces of pinnae bearing short erect hairs throughout.  
 44. Lower 1-3 pairs of pinnae progressively smaller, lowest commonly 1 cm long . . . . . 40. *P. ligulata*  
 44. Lower 5-6 pairs of pinnae less than 2 mm long . . . . . 41. *P. finisterrae*  
 43. No hairs between veins on upper surface, few or none on lower.  
 45. Four or more pairs of lower pinnae gradually reduced; pinnae lobed c. half-way to costa . . . . . 7. *P. costata*
45. Not this combination of characters.  
 46. Pinnae 2-3 cm long.  
 47. Basal pinnae shorter than the next pair . . . . . 42. *P. versteeghii*  
 47. Six pairs of lower pinnae  $\pm$  gradually reduced.  
 48. Basal 3-4 pairs of pinna-lobes separately adnate to costa . . . . . 43. *P. sumbawensis*  
 48. Pinnae lobed half-way to costa . . . . . 53. *P. petrophila*
46. Pinnae much longer.  
 49. Much-reduced basal pinnae 0-3 pairs.  
 50. Sori supramedial; pinnae lobed to 1-2 mm from costa; basal veins from adjacent costules often meeting, or nearly so, at the sinus.  
 51. Pinnae to  $23 \times 4$  cm; basal acroscopic lobe of middle pinnae not almost free . . . . . 44. *P. keysseriana*  
 51. Pinnae c.  $8 \times 1.5$  cm; basal acroscopic lobe of middle pinnae almost free . . . . . 45. *P. caudata*  
 50. Sori medial; pinnae lobed to less than 1 mm from costa; basal veins from adjacent costules ending far apart at the margin.  
 52. Basal basiscopic lobes of middle pinnae equal to acroscopic lobes . . . . . 46. *P. deficiens*  
 52. Basal basiscopic lobes of middle pinnae shorter than acroscopic.  
 53. Basal acroscopic lobes of largest reduced pinnae and lowest normal pinnae elongate.  
 54. Much-reduced basal pinnae 2 pairs; hairs present on lower surface of rachis and costae . . . . . 47. *P. mingendensis*  
 54. Much-reduced pinnae lacking; lower surfaces quite glabrous . . . . . 48. *P. eburnea*  
 53. Basal acroscopic lobes of such pinnae reduced . . . . . 49. *P. excisa*
49. Much-reduced basal pinnae at least 6 pairs.  
 55. Pinnae to 15 cm or more long.  
 56. Reduced pinnae 6 pairs, lowest 1 cm long.  
 57. Pinnae lobed to 1 mm from costa.  
 58. Sori inframedial; dark brown hairs present on upper surface of costa . . . . . 50. *P. regis*  
 58. Sori supramedial; no dark brown hairs . . . . . 44. *P. keysseriana*  
 57. Pinnae lobed to 3.5-4 mm from costa . . . . . 51. *P. boridensis*  
 56. Reduced pinnae many pairs, lower ones smaller . . . . . 52. *P. imbricata*  
 55. Pinnae not or little more than 10 cm long.  
 59. Pinnae lobed half-way to costa . . . . . 53. *P. petrophila*  
 59. Pinnae lobed almost to costa . . . . . 54. *P. walkeri*

1. *Pneumatopteris glabra* (COPEL.) HOLTUM, *Blumea* 21 (1973) 301. — *Cyclosorus glaber* COPEL. Philip. J. Sci. 81 (1952) 34; Fern Fl. Philip. (1960) 363. — *Thelypteris seviliana* REED, *Phytologia* 17 (1968) 313. — Type: RAMOS BS 42976, Sevilla River, Bohol (UC; BM).

*Cyclosorus viridis* COPEL. Philip. J. Sci. 81 (1952) 35, pl. 24; Fern Fl. Philip. (1960) 364. — *Thelypteris viridis* (COPEL.) REED, *Phytologia* 17 (1968) 324. — Type: RAMOS & EDANO BS 37490, Mt Masigit, Luzon (MICH; US, BO).

*Caudex* short, creeping. *Stipe* 5 cm long, basal

scales small, thin, soon disappearing; base of stipe to first large pinna 25–100 cm; stipe and rachis bearing many dark spines, erect or curved, 1 mm long. *Reduced pinnae* many pairs, c. 3 cm apart, each consisting of an aerophore 1–2 mm long, upper ones with a lamina 2–3 mm long almost encircling the aerophore; transition to normal pinnae abrupt or subabrupt; *lamina* excluding reduced pinnae to 120 cm long (sometimes fertile at a length of 30 cm), basal pinnae narrowed near their bases. *Largest pinnae* to 25 cm long, 1.6–2.2 cm wide; base broadly cuneate to full width (asymmetric on upper pinnae); apex caudate-acuminate (cauda to 3 cm long, finely toothed throughout); edges lobed 1/3 towards costa or a little more deeply, lobes entire with acute falcate tips; costules 4–6 mm apart with a small aerophore at the base of each; veins 8–10 pairs, basal pair anastomosing, next 2 pairs passing to sides of a long sinus-membrane; *lower surface* of rachis glabrous, of costae and costules bearing a few small capitate hairs, surface between veins rather strongly pustular; *upper surface* of rachis bearing  $\pm$  abundant thick brown hairs 0.5–1 mm long, similar hairs near bases of costae, rest of upper surface glabrous. *Sori* medial on distal veins, variably supramedial on lower ones; small firm indusia sometimes present; sporangia bearing rather large colourless club-shaped glands.

Distr. *Malesia*: Philippines (Luzon, Samar, Bohol, Mindanao).

Ecol. Usually on rocky stream-banks, to 400–1000 m, also found in ridge forest.

Note. COPELAND distinguished *Cyclosorus viridis* by the green (not dark) colour of dried fronds, narrower pinnae and the presence of small indusia. All these characters appear to be variable. Very young fronds of plants in cultivation at Kew develop a coat of mucilage, as in *P. callosa*. Small indusia, not as large as a mature sporangium, are found in some sori of these plants. RAMOS & EDAÑO, BS 49586, from Mindanao (collected in 1927) was distributed as *Dryopteris todayensis* CHRIST?.

**2. *Pneumatopteris sibelana* HOLTUM**, Blumea 21 (1973) 301. — Type: ALSTON 16942, Batjan, N. slope of Mt Sibela, 1500 m (BM).

*Stipe* less than 5 cm long; base of stipe to first large pinna 45 cm; stipe and rachis bearing slender spines 1 mm long. *Reduced pinnae* 10–12 pairs, each consisting of a semicircular lamina 2–3 mm wide and an aerophore 1 mm or more long; *lamina* exclusive of reduced pinnae 65–70 cm long; pinnae c. 28 pairs, basal ones slightly narrowed at their bases. *Largest pinnae* 12 cm long, 1.8–2.0 cm wide; base subtruncate; apex acuminate with a finely-toothed cauda 10–15 mm long; edges lobed c. 1/3 towards costa, lobes entire, falcate, subacute; costules 5–5.5 mm apart; veins 10 pairs, basal 1–1½ pairs anastomosing, next 2½ pairs to

sides of a long sinus-membrane; on *lower surface* of rachis short curved brown hairs, sparse minute hairs on costae, rest of surface glabrous; *upper surface* glabrous apart from rachis and costae. *Sori* medial, lower ones not or little divergent, exindusiate; no glands seen on sporangia; spores light brown with a  $\pm$  continuous translucent wing and cross-wings.

Distr. *Malesia*: Moluccas (Batjan), only known from the type.

**3. *Pneumatopteris dicranogramma* (v.A.v.R.) HOLTUM**, Blumea 21 (1973) 301. — *Dryopteris dicranogramma* v.A.v.R. Bull. Jard. Bot. Btjg III, 5 (1922) 202. — *Thelypteris dicranogramma* (v.A.v.R.) REED, Phytologia 17 (1968) 272. — Type: BÜNNEMEIJER 10454, Sumatra, G. Kerinci (BO; L).

*Stipe* very short; base of stipe to first large pinna 45–55 cm; stipe and lower part of rachis bearing short dark spines. *Reduced pinnae* c. 2.5–3 cm apart, each consisting of a narrow lamina almost encircling the base of an aerophore. *Lamina* excluding reduced pinnae 50–70 cm long, coriaceous; basal pinnae, several pairs, narrowed at their bases. *Largest pinnae* 17.5 × 1.8 cm; base truncate; apex short-acuminate, serrate to tip; edges lobed 1/3–1/2 towards costa, lobes falcate, acute; costules c. 4 mm apart, each with a small aerophore at its base; veins 10–12 pairs, thick, basal pair anastomosing, then several pairs ending beside a long sinus-membrane; *lower surface* of rachis bearing short stiff brown hairs, a few similar hairs sometimes on bases of costae, rest glabrous; *upper surface* of rachis covered with brown hairs, of costae glabrous. *Sori* in an inverted V (basal ones divergent); indusia soon broken, probably hairy when young.

Distr. *Malesia*: Sumatra (G. Kerinci, 2 collections at 2100–2400 m; G. Dempo).

Note. The specimen from Malaya named *Cyclosorus dicranogramma* in HOLTUM, Rev. Fl. Mal. 2 (1955) 267 is *P. callosa*.

**4. *Pneumatopteris callosa* (BL.) NAKAI**, Bot. Mag. Tokyo 47 (1933) 179; HOLTUM, Blumea 21 (1973) 302. — *Aspidium callosum* BL. En. Pl. Jav. (1828) 152. — *Nephrodium callosum* (BL.) KEYS. Pol. Cyath. Herb. Bung. (1873) 48; RACIB. Fl. Btjg 1 (1898) 192. — *Dryopteris callosa* (BL.) C. CHR. Ind. Fil. (1905) 256; v.A.v.R. Handb. (1908) 220; BACKER & POSTH. Varenfl. Java (1939) 62. — *Cyclosorus callosus* (BL.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 8 (1938) 205. — *Thelypteris callosa* (BL.) K. IWATS. Mem. Coll. Sci. Univ. Kyoto B, 31 (1964) 34. — Type: BLUME, Java (L, n. 908, 339–365).

*Goniopteris lobbiana* FÉE, Gen. Fil. (1852) 251. — Type: LOBB, Java (orig.?; isotypes BM, K).

*Aspidium multijugum* CHRIST, Ann. Jard. Bot.

Btztg 15 (1898) 135. — Lectotype (HOLTUM 1973): SARASIN 1323, Celebes (BAS). — Fig. 11a-c.

*Caudex* stout, erect; apex and fronds in their early stages covered with mucilage. *Stipe* very short; base of stipe to first large pinna 60–100 cm. *Reduced pinnae* 2–4 cm apart, each consisting of a prominent aerophore with a narrow rim at its base; *lamina* excluding reduced pinnae 100–200 cm long, texture very firm; 2–3 pairs of lower pinnae narrowed near their bases. *Largest pinnae* commonly 15–25 cm long, 2.0–2.5 cm wide; base truncate to broadly cuneate; apex rather evenly attenuate; edges lobed 1/4–1/3 towards costa, lobes entire, falcate, subacute, with conspicuous pale cartilaginous edge; costules 3.5–4.5(–5) mm apart, at a wide angle to costa, a small aerophore at the base of each; veins c. 12 pairs, slender and prominent both sides, basal 1–1½ pairs anastomosing, 3–4 pairs passing to sides of the prominent sinus-membrane; *lower surface* of rachis and costae glabrous or with some pale acicular hairs, short hairs present on sinus-membrane and edges, lamina between veins finely and copiously pustular; *upper surface* of rachis (at least distally) bearing long curved brown hairs, a few such hairs near bases of costae, rest of surface glabrous. *Sori* in an inverted V; indusia firm, glabrous; sporangia bearing club-shaped glands, stalks of sporangia bearing hairs with an end-cell which (on young sporangia) is swollen and orange; spores with many small wings.

Distr. *Malesia*: West Malesia, Celebes, Lesser Sunda Is. (Flores) and Moluccas (Ceram).

Ecol. Near streams in forest, at 600–1750 m.

Notes. BLUME distinguished *var. B.* with more rigid fronds and sori confluent; I have not seen the type, and consider the distinctions not good. v.A.v.R. described *var. sumatrana* (Handb. 220) from a small plant with gradually reduced lower pinnae; it might represent another species (type not found). CHRIST gave a brief description of the SARASIN specimen from Celebes cited under *Aspidium multijugum*, referring to *Nephrodium multijugum* BAK. Syn. Fil. (1867) 291 and ascribing the name to WALLICH, but WALLICH included specimens of three different species under his n. 348 and it is not clear to which of them BAKER's description applies, though certainly not to *P. callosa*. I have not seen the WARBURG specimens also cited by CHRIST.

**5. *Pneumatopteris subappendiculata*** (COPEL.) HOLTUM, Blumea 21 (1973) 303. — *Dryopteris subappendiculata* COPEL. Univ. Cal. Publ. Bot. 18 (1942) 220. — *Cyclosorus subappendiculatus* (COPEL.) COPEL. Gen. Fil. (1947) 143; Philip. J. Sci. 78 (1951) 449, pl. 30. — *Thelypteris subappendiculata* (COPEL.) REED, Phytologia 17 (1968) 317. — Type: BRASS 12247, New Guinea, Idenburg River (MICH; L).

*Stipe* 10 cm long, covered with short brown

hairs and when young thin scales; base of stipe to first large pinna 35 cm. *Reduced pinnae* to 7 pairs, lowest 5 mm long, uppermost 2 cm long, broadly triangular with auricled acroscopic base. *Lamina* excluding reduced pinnae to 90 cm long; pinnae c. 16 pairs, opposite, with conical aerophores at their bases; basal pinnae auricled on acroscopic side or ± dilated both sides at base; texture firm. *Largest pinnae* 18 × 3 cm (sterile), fertile to 2.5 cm wide; base truncate to subcordate; apex short-acuminate; edges crenately lobed, sterile to a depth of 2 mm, fertile to 3 mm; costules 5–6 mm apart; veins 6–7 pairs, slender, prominent both sides, basal 1½–2 pairs anastomosing, next 1–2 pairs to sides of sinus-membrane which is not prominent on lower surface; *lower surface* of rachis bearing rather sparse thick brown hairs, costae, costules and sinus-membrane sparse slender short hairs, surface between veins slightly pustular; *upper surface* of rachis covered with brown hairs, those on costae paler and more slender. *Sori* medial (distal ones inframedial); indusia thin, pale, with a few short hairs; sporangia lacking glands.

Distr. *Malesia*: Eastern New Guinea, at 1400–2200 m.

Note. It is not clear whether this is sharply distinct from *P. superba*.

**6. *Pneumatopteris superba*** (BRAUSE) HOLTUM, Blumea 21 (1973) 303. — *Dryopteris superba* BRAUSE, Bot. Jahrb. 56 (1920) 105. — *Cyclosorus superbus* (BRAUSE) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 249; COPEL. Philip. J. Sci. 78 (1951) 447. — *Thelypteris superba* (BRAUSE) REED, Phytologia 17 (1968) 318. — Type: LEDERMANN 11733, N.E. New Guinea, Sepik Distr., Schraderberg 2070 m (B).

*Dryopteris deltiptera* COPEL. Univ. Cal. Publ. Bot. 18 (1942) 142. — *Cyclosorus deltipterus* COPEL. Gen. Fil. (1947) 142; Philip. J. Sci. 78 (1951) 449, pl. 29. — *Thelypteris deltiptera* (COPEL.) REED, Phytologia 17 (1968) 271. — Type: BRASS 11260, New Guinea, near Lake Habbema 2200 m (GH).

Differs from *P. subappendiculata*: caudex short, erect; stipes of largest fronds bearing a few spines less than 0.5 mm long; fronds larger; pinnae to 23 cm long, ± dilated at base which in largest fronds is 3–4 cm wide, asymmetric (wider throughout on basicopic side of costa than on acroscopic side), edges lobed up to 1/3 towards costa, more deeply on basicopic than on acroscopic side; lobes with broad undulate cartilaginous edges; costules 6–7 mm apart; veins 10–16 pairs; basal sori not much divergent.

Distr. *Malesia*: Eastern New Guinea, many collections; 2 doubtful from W. New Guinea.

Ecol. In forest at 1700–2700 m.

**7. *Pneumatopteris costata*** (BRACK.) HOLTUM, Blumea 21 (1973) 305; Allertonia 1 (1977) 229, f.



9b. — *Goniopteris costata* BRACK. in Wilkes, U.S. Expl. Exp. (1854) 28. — *Dryopteris costata* (BRACK.) MAXON, Univ. Cal. Publ. Bot. 12 (1924) 26. — *Thelypteris costata* (BRACK.) REED, Phytologia 17 (1968) 269. — Type: U.S. Expl. Exped., Fiji (US).

*Lastrea cavitensis* COPEL. Philip. J. Sci. 81 (1952) 26; Fern Fl. Philip. (1960) 328. — *Thelypteris cavitensis* (COPEL.) REED, Phytologia 17 (1968) 267. — Type: MANGUBAT BS 1302, Luzon, Cavite (MICH).

*Dryopteris pennigera* (FORST. f.) C. CHR. subsp., C. CHR. Ind. Fil. (1905) 289. — *Dryopteris luzonica* CHRIST, Philip. J. Sci. 2 (1907) Bot. 196, *quoad Mangubat* 1302 *tantum*.

*Caudex* short, erect; *stipe* 5–10 cm long, basal scales broad, thin, imbricating. *Lamina* to 80 cm long; pinnae to more than 25 pairs, basal 4–8 pairs gradually decrescent, lowest 3–12 mm long; reduced pinnae not auricled nor narrowed at their bases; texture thin but firm. *Largest pinnae* to 14 × 1.5 cm (type of *L. cavitensis* 8 × 0.8 cm); base broadly cuneate to subtruncate; apex narrowly acuminate; edges lobed c.  $\frac{1}{2}$  way to costa; costules to 4 mm apart (2.5 mm in type of *L. cavitensis*); veins in well-grown plants 8–9 pairs, basal veins anastomosing, next acroscopic vein or pair to short sinus-membrane (in type of *L. cavitensis* 4–6 pairs of veins, basal ones meeting without joining at sinus-membrane); *lower surface* of rachis and costae bearing many minute acicular hairs, such hairs sparse on costules and veins, on and between veins minute sessile or subsessile glands which collapse on drying; *upper surface* of rachis and costae covered with pale hairs more than 0.5 mm long, between veins minute glands as lower surface. *Sori* inframedial, exindusiate or sometimes with very small indusia; sporangia bearing small capitate hairs; spores pale, with a ± continuous thin translucent wing and cross-wings. Chromosomes:  $n = 36$  (T. G. WALKER).

*Distr.* Queensland, Solomon Islands, New Hebrides, New Caledonia, eastwards to Tahiti; *var. hispida* HOLTUM in Cook Islands, Pitcairn, Easter Island (see HOLTUM in Allertonia 1977), in *Malesia*: N.E. New Guinea, Philippines (S. Luzon), and Lesser Sunda Is. (Bali, Sumbawa).

*Ecol.* In *Malesia* at 250–1200 m, on sloping ground near streams, apparently not in deep shade.

*Note.* This species has been much misinterpreted; the first author after BRACKENRIDGE to characterize it clearly was MAXON (1924) but he did not see the characteristic minute glands. The fern so named by HOOKER (Spec. Fil. 5, 1864, 7) is *Chingia longissima* (BRACK.) HOLTUM. DIELS and CHRISTENSEN confused *P. costata* with *P. pennigera* (FORST. f.) HOLTUM of New Zealand and S.E. Australia; some specimens from Samoa were named *Dryopteris transversaria* and *D. christophersenii* by CHRISTENSEN.

8. *Pneumatopteris latisquamata* HOLTUM, Blumea 21 (1973) 305. — Type: MILLAR & HOLTUM NGF 15777, N.E. New Guinea, Morobe Distr., Edie Creek, 2000 m (K; BO, LAE).

*Caudex* short; apex covered with imbricating firm, apparently hairless scales; *stipe* 4 cm long, minutely hairy, scales early caducous. *Lamina* 35 cm long; pinnae c. 24 pairs, lower 8 pairs gradually shorter, lowest 2 cm long, all with symmetric bases; texture firm, rigid when dried. *Largest pinnae* 3.5 × 0.8 cm; base broadly cuneate; apex short-acuminate; edges lobed c.  $\frac{1}{2}$  way to costa; lobes slightly falcate, their edges reflexed when dried; costules 2 mm apart; veins 4 pairs, lowest anastomosing, next pair to margin; *lower surface* of rachis densely covered with erect acicular hairs 0.3–0.4 mm long, more sparse and shorter similar hairs on costae, costules and veins and on surface between veins, minute sessile or subsessile glands on all parts; *upper surface* of rachis covered with pale hairs more than 0.5 mm long, shorter hairs on costae, rest of pinna bearing many suberect acicular hairs 0.2 mm long and many short capitate hairs or small glands. *Sori* probably medial, confluent at maturity and covering most of lower surface, exindusiate; sporangia bearing either a short seta or a short capitate hair; spores with extended sinuous wings which are joined together irregularly.

*Distr.* *Malesia*: Papua New Guinea, only known from the type.

*Note.* Allied to *P. costata* but very distinct.

9. *Pneumatopteris egenolfioides* HOLTUM, Blumea 21 (1973) 306. — Type: BRASS 11497, New Guinea, near Lake Habbema, 2200 m, on limestone cliffs (L; BM, BO, MICH).

*Caudex* slender, procumbent, 8 cm long with a tuft of stipes at apex; *stipe* 10–17 cm long, pale, glabrous, base covered with dark ovate-acute glabrous scales 1.2 mm long. *Lamina* to 45 cm long; pinnae to 28 pairs, firm to rigid, 3–4 lower pairs gradually smaller and more widely spaced, lowest 5–7 mm long. *Largest pinnae* 2.4–3.2 cm long, 0.6–0.8 cm wide, base strongly auricled on acroscopic side, narrowly cuneate on basiscopic; apex narrowed, subtruncate with a small mucro; edges lobed c.  $\frac{1}{3}$  towards costa; lobes oblique, near bases of larger pinnae obliquely truncate with teeth at vein-ends; costules 3 mm apart, at little more than 45° to costa; veins mostly 2 pairs (3 pairs in basal auricle), 1 pair anastomosing with a short excurrent vein to the sinus-membrane, free in distal part of pinna, pale and prominent on lower surface; *lower surface* hairless, with residual very small scales on costae, costules and veins, surface between veins pustular; *upper surface* hairy on rachis and bases of costae only. *Sori* only on basal acroscopic vein of each group, near costule; indusium firm, glabrous; a short capitate hair present on some sporangia.

Distr. *Malesia*: W. New Guinea (Habbema).  
Ecol. Limestone cliffs at 2200 m.

**10. *Pneumatopteris patentipinna* HOLTUM**, *Blumea* 21 (1973) 307. — Type: T. G. WALKER 8477, N.E. New Guinea, trail from Moro to Sewi (BM).

*Caudex* short-creeping; *stipe* 5–15 cm long, pale, glabrescent or with a few brown hairs, basal scales thin, caducous. *Lamina* to 60 cm long (of type 35 cm); 5–10 pairs of lower pinnae gradually smaller, lowest less than 1 cm long; *reduced pinnae* either auricled on acroscopic base or dilated both sides, middle ones broadly triangular, opposite or not; all pinnae at right angles to rachis; texture firm. *Largest pinnae* of type 4.0 cm long, 1.1 cm wide above auricled base, of largest plants seen  $8.5 \times 1.8$  cm; base truncate; apex short-acuminate, slightly upcurved; edges of pinnae of largest fronds lobed  $\frac{1}{2}$  way to costa, of smaller fronds less deeply, lobes truncate with acute falcate apex,  $\pm$  toothed at ends of veins; costules 3–4 mm apart; veins 4–6 pairs, pale and prominent, 1 pair anastomosing, next vein to sinus-membrane or edge; *lower surface* of rachis and costae bearing a variable number of brown hairs, some short pale hairs also on costae, rather sparse large pustules on surface between veins; *upper surface* of rachis covered with thick brown hairs to 1 mm long, hairs on costae shorter, few, pale distally. *Sori* medial, indusia large, thin, bearing a variable number of short acicular hairs; no glandular hairs on sporangia. Chromosomes:  $n = 36$  (T. G. WALKER).

Distr. *Malesia*: Eastern New Guinea, at 1650–2300 m.

Note. The type appeared to be very distinct, but later collections indicate a possible gradation to the condition of *P. jerryi*.

**11. *Pneumatopteris cheesmaniae* HOLTUM**, *Blumea* 21 (1973) 307. — Type: L. E. CHEESMAN 1269, Japen Island, Aian Range, 300 m, in forest on old coral limestone (BM).

*Stipe* at least 14 cm long, pale, glabrous; *lamina* 26 cm long, pinnae c. 14 pairs, basal 3 pairs of pinnae gradually reduced, lowest 3–5 mm long. *Largest pinnae* 3.3 cm long, 1.1 cm wide above auricled base, basiscopic base truncate; apex short-pointed; edges lobed  $2/5$  or a little more deeply; lobes  $\pm$  quadrate, apices subtruncate with slight projections at vein-ends, edge not conspicuously cartilaginous; costules 3–3.5 mm apart, almost at right angles to costa; veins 3 pairs except in basal auricle which has 4–5 pairs, slender, concolorous, basal ones meeting to form a very short excurrent vein below the sinus or in smaller pinnae meeting at the sinus-membrane; *lower surface* quite hairless, surface between veins slightly pustular; *upper surface* not seen. *Sori* inframedial, lowest not divergent, exindusiate; sporangia often with a pear-shaped small gland.

Distr. *Malesia*: New Guinea (Japen I.), only known from type.

Ecol. In forest on old coral limestone, 300 m altitude.

**12. *Pneumatopteris lithophila* HOLTUM, sp. nov.**

*Lamina* 30 cm longa; pinnae 16–18-jugatae, inferiores 6–7-jugatae sensim decrescentes; pinnae maximae  $3.0 \times 1.0$  cm, marginibus crenatis, apicibus rotundatis, pagina inferiore fere glabra; rachis supra pilis brunneis vestita, pinnae supra inter venas pilis erectis acicularibus minutis praeditae; sori mediales, indusia glabra. — Type: M. G. PRICE & B. F. HERNAEZ 779, Western Samar, on limestone cliff in forest, 700 m (K).

*Caudex* short; *stipe* 3–6 cm long, pale, hairy in groove, basal scales very small, broad, thin. *Lamina* 30 cm long; pinnae 16–18 pairs, 6–7 lower pairs gradually decrescent, lowest  $3 \times 3$  mm; texture thin. *Largest sterile pinnae*  $3.0 \times 1.1$  cm, fertile  $2.5 \times 1.0$  cm; base truncate, a little auricled on acroscopic side; apex rounded; edges crenate to a depth of 1–1.5 mm; costules 2.5 mm apart; veins 3–4 pairs at base of largest pinnae, basal pair anastomosing to form an excurrent vein to the short sinus-membrane, next acroscopic vein to the membrane or the margin; *lower surface* of rachis glabrous, very sparse minute acicular hairs present on costae and costules, sometimes also between veins, a few short capitate hairs on costules, veins and on surface between veins which is slightly pustular; *upper surface* of rachis covered with slender brown hairs 1 mm long, hairs on costae pale and shorter, short erect acicular hairs rather sparse on surface between veins. *Sori* medial; indusia small, glabrous; neither glands nor setae on sporangia; spores pale, with many small wings.

Distr. *Malesia*: Philippines (W. Samar), 2 coll. from type locality.

Ecol. On limestone cliff in forest at 700 m altitude.

**13. *Pneumatopteris angusticaudata* HOLTUM**, *Blumea* 21 (1973) 308. — Type: BRASS 24984, New Guinea, Goodenough Island, 800 m, on a rock-face beside a stream (BM; LAE).

*Fronds* pendent (collector); *stipe* short; base of stipe to first large pinna 50–55 cm; *reduced pinnae* 6 pairs, 3–5 mm long, then 2 pairs of intermediate length. *Lamina* excluding reduced pinnae 65 cm long; pinnae 25 pairs; several pairs of lower pinnae narrowed towards their bases, especially on basiscopic side; texture firm. *Largest pinnae*  $15 \times 1.2$  cm; base broadly cuneate to full width on acroscopic side, narrowly cuneate on basiscopic; apex acuminate with subentire cauda 4–5 cm long and 1 mm wide; edges lobed to a depth of 2 mm; lobes very oblique, falcate, subacute, entire; costules 4 mm apart; veins 4–5 pairs, 1 pair anastomosing, next acroscopic vein to side of sinus-

membrane; lower surface quite glabrous; upper surface of rachis bearing a few short hairs, similar hairs on bases of costae, rest glabrous. Sori medial; indusia small, thin, with many short hairs; no glands nor setae on sporangia.

Distr. *Malesia*: Papua New Guinea (Goodenough I.), known from the type only.

Ecol. Rock-face beside a stream at 800 m altitude.

**14. *Pneumatopteris microloncha*** (CHRIST) HOLTUM, *Blumea* 21 (1973) 308. — *Dryopteris microloncha* CHRIST, Philip. J. Sci. 2 (1907) Bot. 202. — *Cyclosorus microlonchus* (CHRIST) COPEL. Gen. Fil. (1947) 143; Fern Fl. Philip. (1960) 366. — *Thelypteris microloncha* (CHRIST) REED, *Phytologia* 7 (1968) 293. — Lectotype (HOLTUM 1973): MANGUBAT BS 1304, Cavite, Luzon (P).

*Dryopteris caudiculata* v.A.v.R. Handb. (1908) 820 (based on *Nephrodium caudiculatum* J. Sm. nom. nud.).

*Caudex* erect; *stipe* 4–10 cm long, pale, glabrous, scales broad, thin, not persistent. *Lamina* 25–45(–55) cm long; pinnae 15–25 pairs, texture thin; 3–6 pairs of lower pinnae gradually smaller, lowest 3–5 mm long. *Largest pinnae* 3–12 cm long, 0.6–1.5 cm wide; base subtruncate, a little dilated both sides or only on acroscopic side; apex acuminate,  $\pm$  caudate on longest pinnae; edges lobed  $\frac{1}{2}$  way to costa; lobes obliquely quadrate,  $\pm$  dentate at ends of veins; costules 2–4 mm apart; veins 3–4(–6) pairs, slender and prominent, 1 pair anastomosing, next pair to sinus-membrane on larger pinnae; lower surface bearing short slender erect hairs throughout; upper surface of rachis bearing slender pale hairs 0.5 mm long, similar hairs sparse on costae, no others. Sori medial; indusia short-hairy; sporangia with rather large pale or yellowish club-shaped hairs.

Distr. *Malesia*: Philippines (Luzon, Negros).

Ecol. At low altitudes on rocky stream-banks.

Note. CHRIST cited several specimens (the lectotype is the best in his herbarium), among them CUMING 317, which is one of several numbers cited by JOHN SMITH under "*Nephrodium caudiculatum* PRESL" (a non-existent name), the others representing *Sphaerostephanos productus*. v.A.v.R., adopting SMITH's name, copied CHRIST's description. Plants are fertile from a small size.

**15. *Pneumatopteris brooksii*** (COPEL.) HOLTUM, *Blumea* 21 (1973) 308. — *Dryopteris brooksii* COPEL. Philip. J. Sci. 3 (1908) Bot. 345; v.A.v.R. Handb. Suppl. (1917) 185. — *Thelypteris brooksii* (COPEL.) REED, *Phytologia* 17 (1968) 265. — Type: C. J. BROOKS s.n. April 1908, Bidi, Sarawak (MICH; BM).

*Caudex* erect or suberect; *stipe* 20–50 cm long, pale, glabrescent, basal scales appressed; base of *stipe* to first large pinna 40–70 cm; reduced pinnae

3–4 pairs, 4–5 mm long. *Lamina* excluding reduced pinnae 75 cm long; pinnae more than 40 pairs, texture firm; several pairs of lower pinnae gradually narrowed towards their bases, not auricled. *Largest pinnae* 10–12.5  $\times$  1.0–1.3 cm; base abruptly broad-cuneate; apex evenly and narrowly attenuate; edges lobed c.  $\frac{1}{3}$  towards costa, lobes slightly oblique with rounded apices; costules 3.5–4 mm apart; veins 4–5 pairs (to 7 pairs in largest sterile pinnae), slender, 1 pair anastomosing with a long excurrent vein, next veins to edge; lower surface quite glabrous, hardly pustular; a few short pale hairs in groove of upper surface of rachis, few or none on costae. Sori medial; indusia small, firm, glabrous; sporangia lacking glandular hairs.

Distr. *Malesia*: Borneo (Sarawak), several collections.

Ecol. On limestone.

**16. *Pneumatopteris inclusa*** (COPEL.) HOLTUM, *Blumea* 21 (1973) 306. — *Dryopteris inclusa* COPEL. Univ. Cal. Publ. Bot. 14 (1929) 373, pl. 57. — *Thelypteris inclusa* (COPEL.) REED, *Phytologia* 17 (1968) 284. — Type: BARTLETT 8576, Sumatra, Karo Plateau (UC).

*Dryopteris berastagiensis* C. CHR. Dansk Bot. Ark. 9, 3 (1937) 59. — Type: RIDLEY s.n. 1921, Sumatra, Berastagi (K).

*Caudex* creeping, 10 mm diameter; *stipe* not seen. *Lamina* to at least 100 cm long; pinnae to 20 pairs, thin but firm; basal pinnae not or slightly reduced. *Largest pinnae* 28  $\times$  5 cm; base of lower pinnae cuneate, of upper ones truncate; apex abruptly short-acuminate; edges lobed  $\frac{1}{4}$  towards costa or less deeply; lobes obliquely truncate with slight teeth at ends of veins; costules 6.5–7.5 mm apart, at a little more than 60° to costa; veins 10–12 pairs, slender,  $2\frac{1}{2}$  pairs anastomosing,  $2\frac{1}{2}$ –3 pairs passing to sides of sinus-membrane; lower surface glabrous in type, with sparse slender hairs on costae and costules of another specimen; upper surface with short hairs on rachis and costae only. Sori medial; indusia thin with a few short hairs; hairs on stalks of sporangia with swollen orange end-cell; spores with many small wings.

Distr. *Malesia*: Central and north Sumatra, several collections.

Note. There is some variation among the specimens included here. One collected by C. G. MATTHEW at Padang Panjang has thinner pinnae than the type, with slender hairs on lower surface of costae and costules; it also has the basal pair of pinnae distinctly reduced (12 and 17 cm long) with much-narrowed bases. Other collections show different parts of fronds and are difficult to compare.

**17. *Pneumatopteris longipes*** (BL.) HOLTUM, *Blumea* 21 (1973) 306. — *Aspidium longipes* BL. En. Pl. Jav. (1828) 155; MIQUEL, Ann. Mus. Bot.

Lugd.-Bat. 4 (1869) 158. — *Nephrodium longipes* (BL.) MOORE, Ind. Fil. (1868) 95; RACIB. Fl. Btzg 1 (1898) 182. — *Dryopteris longipes* (BL.) O. KTZE, Rev. Gen. Pl. 2 (1891) 813; v.A.v.R. Handb. (1908) 211; BACKER & POSTH. Varenfl. Java (1939) 58. — *Thelypteris longipes* (BL.) REED, Phytologia 17 (1968) 289. — Type: BLUME, Java, Boerangrang (L, n. 908,335-1062).

*Caudex* long-creeping, to 10 mm diameter; *stipe* c. 100 cm long, pale, glabrous, basal scales c. 10 × 4 mm. *Lamina* c. 100 cm long; pinnae to 35 pairs; basal pair of pinnae not opposite, not auricled, variably unequal and reduced, in some cases 2.5 cm long, in others much longer, ± narrowed near their bases. *Largest pinnae* 17–22 × 2.2–3.0 cm; base truncate; apex narrowly acuminate; edges lobed c. 2/3 towards costa, lobes with rounded tips, at most slightly dentate at vein-ends; costules 4 mm apart; veins to 11 pairs, lowest only anastomosing, next pair to margin or to the short sinus-membrane; sparse erect hairs on lower surface of costules and distally on costae, on sinus-membranes and margin, surface between veins finely and not copiously pustular; upper surface hairy on rachis and costae only. *Sori* medial; indusia small, hairy; sporangia sometimes with a small capitate hair.

Distr. *Malesia*: Java, at 1400–1800 m.

**18. *Pneumatopteris laevis* (METT.) HOLTUM**, Blumea 21 (1973) 308. — *Aspidium laeve* METT. Farngatt. IV (1858) 104. — *Dryopteris laevis* (METT.) C. CHR. Ind. Fil. (1905) 273; v.A.v.R. Handb. (1908) 220. — *Thelypteris laevis* (METT.) REED, Phytologia 17 (1968) 286. — Neotype (HOLTUM 1973): JAGOR, Samar (B, ex Herb. Mett.).

*Dryopteris luzonica* CHRIST, Philip. J. Sci. 2 (1907) Bot. 196, excl. var. *puberula*; v.A.v.R. Handb. (1908) 821, excl. var. *puberula*. — Lectotype (HOLTUM 1973): LOHER s.n. Jan. 1906, Mt Makiling, Luzon (P).

*Cyclosorus nitidulus* sensu COPEL. Fern Fl. Philip. (1960) 364, p.p. — *Cyclosorus microlonchus* sensu COPEL. *ibid.* 366, p.p. — Fig. 11g–h.

*Caudex* quite prostrate with closely seriate fronds; *stipe* 12–18 cm long, pale, glabrous; base of stipe to first large pinna c. 30 cm; *reduced pinnae* 3–5 pairs, transition to large ones gradual or subabrupt, lowest 5–10 mm long, all strongly auricled on acroscopic base. *Lamina* in all 50–80 cm long (sometimes fertile at a smaller size); pinnae to 25 pairs. *Largest pinnae* to 18 cm long, 1.4–2.0 cm wide; middle and upper pinnae oblique, with very asymmetric base, auricled on acroscopic side, narrower and rounded on basiscopic; apex caudate-acuminate (cauda 2–4 cm long); edges lobed c. 1/3 towards costa; lobes oblique, subtruncate with teeth at vein-ends; costules 4–4.5 mm apart; veins 5–8 pairs, slender, basal pair anastomosing, next acroscopic vein to sinus-

membrane; lower surface quite glabrous, slightly pustular between veins; upper surface bearing short pale hairs on rachis and costae (in a few cases hairs on rachis red-brown). *Sori* medial, lower ones not divergent; indusia glabrous or with a few short acicular or capitate hairs on edges; sporangia usually lacking glands. *Chromosomes*: n = 36 (T. G. WALKER, plant cult. Kew).

Distr. *Malesia*: Philippines (Luzon, Negros, Samar, Leyte, Mindanao).

Ecol. On rocky banks of streams, with pendulous fronds; low altitudes.

Notes. Mettenius cited as type “Cuming 83 bis ex parte”; this is not represented in his herbarium at Berlin. The neotype is one named by him and agreeing with his description. Copeland’s treatment is very confused. M. G. Price has sent to Kew several dried specimens and also living plants which have supplied information for the above description. One of his specimens has red-brown hairs on the rachis and a few capitate hairs on its sporangia.

**19. *Pneumatopteris obliqua* HOLTUM**, Blumea 21 (1973) 309. — Type: P. & F. SARASIN 127, Masarang, N. Celebes (BAS).

*Caudex* short-creeping; *stipe* c. 40 cm long, pale, glabrous; base of stipe to first large pinna 90 cm or more; *reduced pinnae* to 12 pairs, all c. 3 × 3 mm or the uppermost a little larger, transition to large pinnae abrupt. *Lamina* excluding reduced pinnae to 65 cm long; pinnae 25 pairs, all except lower ones very oblique; several pairs of lower pinnae gradually narrowed towards their bases, not auricled. *Middle pinnae* to 16 × 1.6–1.9 cm; base very asymmetric, basal basiscopic lobe much reduced, basal acroscopic lobe not longer than next; apex acuminate with almost entire cauda 3–4 cm long; edges lobed c. 3/5 towards costa, lobes with falcate acute tips and slight teeth at vein-ends; costules to 5 mm apart, at c. 50° to costa; veins slender, 7–8 pairs, basal pair meeting at base of sinus-membrane, next acroscopic vein passing to side of membrane, rest to margin; lower surface of rachis rather densely covered with hairs 0.1–0.2 mm long, similar hairs more sparse on costae, surface between veins with rather sparse large pustules; upper surface of rachis and costae bearing pale hairs to 0.5 mm long. *Sori* medial; indusia thin, glabrous or with a few short hairs; sporangia sometimes with small capitate hairs.

Distr. *Malesia*: North Celebes, in forest at 1100–1200 m (5 collections).

**20. *Pneumatopteris basicurtata* HOLTUM**, Blumea 21 (1973) 309. — Type: ROBINSON & KLOSS 148, G. Kerinci, Sumatra, 2250 m (BM).

*Stipe* 42 cm long, pale, minutely hairy; *lamina* 50 cm long, comprising 15 pairs normal pinnae and one basal pair 2 cm long, 1.2 cm wide at base which is strongly auricled on acroscopic side;

lowest normal pinnae more widely-spaced, deflexed, much narrowed at their bases on basiscopic side; texture thin but firm. *Largest pinnae* of type  $12 \times 2.4$  cm, of BÜNNEMEIJER 10296  $19 \times 2.7$  cm; base truncate, slightly dilated both sides; apex short-acuminate; edges lobed a little more than  $\frac{1}{2}$  way to costa; lobes falcate with  $\pm$  acute tips, not toothed at vein-ends; costules  $5-5.5$  mm apart, at a wide angle; veins 9-10 pairs, basal pair anastomosing, next pair to sinus-membrane; lower surface quite glabrous except for a few slender hairs on costules and veins near tips of lobes, also on sinus-membrane and margin. *Sori* medial; indusia large, rather firm, with a few hairs; sporangia sometimes with capitate hairs.

Distr. *Malesia*: Sumatra: G. Kerinci (2 collections) and near Lake Toba.

Note. It is possible that these specimens are not distinct from *P. longipes* of Java; information about the caudex and constancy of basal pinnae is needed.

**21. *Pneumatopteris microauriculata* HOLTUM**, Blumea 21 (1973) 311. — Type: CLEMENS 27137, Mt Kinabalu, Sabah, 850 m (BM).

*Caudex* short-creeping with closely seriate fronds; *stipe* 50-70 cm long, pale except near base, glabrous, basal scales c.  $2.5 \times 2.0$  mm. *Lamina* 35-40 cm long, consisting of c. 18 pairs normal pinnae and 1 pair 1 mm long 6-8 cm below basal normal pair; basal pinnae narrowed gradually towards their bases which are 8 mm wide, not auricled; texture firm. *Largest pinnae*  $12 \times 1.6$  cm; base somewhat asymmetric, truncate and slightly auricled on acroscopic side, narrow and rounded on basiscopic; apex upcurved, acuminate, serrate to tip; edges lobed c.  $2/5$  towards costa; lobes falcate, broadly pointed, not toothed; costules  $3.5-4$  mm apart, at a wide angle to costa; veins 8 pairs, concolorous, prominent both sides, 1 pair anastomosing,  $1\frac{1}{2}-2$  pairs passing to sides of sinus-membrane; lower surface of rachis glabrous, costae bearing very short pale hairs distally, a few hairs on sinus-membrane, surface between veins pustular; upper surface hairy on rachis and costae only. *Sori* a little inframedial, lower ones not divergent; indusia large, thin, glabrous, caducous; sporangia lacking glands.

Distr. *Malesia*: Borneo (Sabah: Mt Kinabalu), 3 collections.

**22. *Pneumatopteris ecallosa* (HOLTUM) HOLTUM**, Blumea 21 (1973) 310. — *Cyclosorus ecallosus* HOLTUM, Gard. Bull. Sing. 11 (1947) 269; Rev. Fl. Mal. 2 (1955) 272, f. 156. — *Thelypteris ecallosa* (HOLTUM) REED, Phytologia 17 (1968) 274. — Type: HOLTUM 31294, Cameron Highlands, Malaya (SING; BO, K).

*Caudex* short-creeping; *stipe* to 100 cm long, pale except near base, glabrous, scales thin, adherent. *Lamina* to 100 cm long, consisting of c. 35

pairs normal pinnae and at the base 2-3(-4) pairs of subequal opposite pinnae c.  $2.5 \times 2.5$  cm, deeply lobed, strongly auricled on the acroscopic side; several pairs of lower normal pinnae narrowed towards their bases with a lobed acroscopic auricle; texture thin. *Largest pinnae* commonly  $20 \times 2.2$  cm, sterile pinnae to  $28 \times 3$  cm; base truncate; apex narrowly attenuate; edges lobed c.  $\frac{1}{2}$  way to costa (sterile pinnae often more deeply); lobes not falcate, truncate with slight teeth at vein-ends; costules to 5 mm apart, at a wide angle to costa; veins 7-12 pairs, prominent both sides, lowest pair anastomosing, next pair to sinus-membrane; lower surface quite glabrous, minutely pustular between veins; upper surface of rachis and costae bearing short pale hairs. *Sori* inframedial, lower ones not divergent; indusia thin, glabrous; sporangia bearing many short club-shaped glands.

Distr. *Malesia*: Malaya (middle and north of Main Range).

Ecol. Near streams in forest; now abundant in secondary growth near streams where forest has been felled at Cameron Highlands, 1500 m.

**23. *Pneumatopteris auctipinna* HOLTUM**, Blumea 21 (1973) 310; Reinwardtia 8 (1974) 499. — Type: P. & F. SARASIN 119, N. Celebes, Tomohon (BAS).

*Aspidium truncatum* var. *celebicum*? MIQUEL, Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 160. — Type: DE VRIESE, Menado, N. Celebes (L).

*Aspidium truncatum* sensu CHRIST, Ann. Jard. Bot. Btzig 15 (1898) 133, as regards specimens cited from Celebes.

*Caudex* short, erect (ALSTON); *stipe* 20 cm long, pale, minutely hairy; base of *stipe* to first large pinna 75 cm; *reduced pinnae* c. 8 pairs, all with a broad asymmetric base which is enlarged to form a serrate auricle, uppermost  $2.5-4.0 \times 2-3$  cm, lowest  $1.5 \times 1.5$  cm. *Lamina* excluding reduced pinnae 80 cm or more long; pinnae c. 25 pairs, thin but firm, 2-3 lower pairs with  $\pm$  auricled base as reduced pinnae. *Largest pinnae*  $20 \times 2.5$  cm; base truncate (except sub-basal ones); apex caudate-acuminate (cauda 2.5 cm, sinuous or crenate); edges lobed  $1/2-1/3$  towards costa; lobes subtruncate to rounded with slight teeth at vein-ends; costules  $4-4.5$  mm apart, at a wide angle to costa; veins 8-10 pairs, slender, prominent both sides, often pale reddish on lower surface, basal  $1-1\frac{1}{2}$  pairs anastomosing, next  $2-2\frac{1}{2}$  pairs to the sinus-membrane; lower surface of rachis and costae rather densely covered with short erect pale hairs, sparse hairs on costules, veins and on surface between veins which is finely pustular; hairs on upper surface of costae pale, 0.5 mm long, rest of surface glabrous. *Sori* a little inframedial, basal ones not divergent; indusia small, short-hairy; sporangia bearing capitate hairs.

Distr. *Malesia*: North & Central Celebes, East Java, Lesser Sunda Is. (Flores) and Moluccas (Buru & Amboina), 900-2000 m.

Note. SARASIN 124 bears a note that young fronds are rose-coloured.

**24. *Pneumatopteris jermyi* HOLTUM**, *Blumea* 21 (1973) 310. — Type: JERMY 3739, N.E. New Guinea, Butemu, Moro Trail (BM).

*Caudex* short, suberect; *stipe* 23 cm long, pale, hairs brown, sparse above base; base of stipe to first large pinna 50 cm; *reduced pinnae* c. 6 pairs, not opposite, uppermost 1.5–2.0 cm long, 0.8 cm wide at base which is truncate and slightly auricled on acroscopic side, lowest 2–3 mm long,  $\pm$  orbicular. *Lamina* excluding reduced pinnae 60 cm long; pinnae 22 pairs, texture thin but firm; lowest pinnae slightly narrowed towards their bases,  $\pm$  auricled on acroscopic side. *Largest pinnae* of type  $13 \times 1.8$  cm (of another specimen  $14 \times 2.5$  cm); base truncate; apex acuminate with narrow subentire cauda 2–3.5 cm long; edges lobed  $\frac{1}{2}$  way to costa or a little less deeply, lobes subtruncate with slight projections at vein-ends; costules 4 mm apart, at a wide angle to costa; veins to 9 pairs, concolorous, basal pair meeting at an obtuse angle to produce a slender excurrent vein which may be joined by another vein before entering base of sinus-membrane, next pair of veins to sides of the membrane; *lower surface* of rachis bearing stiff curved brown hairs more than 0.5 mm long, similar hairs near bases costae grading to pale hairs distally, rest of surface almost glabrous; *upper surface* of rachis and costae hairy as lower. *Sori* inframedial, lower ones not divergent; indusia short-hairy; sporangia lacking glands.

Distr. *Malesia*: Eastern New Guinea, 1150–2000 m.

**25. *Pneumatopteris papuana* HOLTUM**, *Blumea* 21 (1973) 311. — Type: BRASS 22778, Mt Dayman, E. New Guinea, 2000 m (LAE; BM, L).

Differs from *P. jermyi* as follows: *lamina* excluding reduced pinnae to 150 cm long; largest pinnae  $18 \times 3.5$  cm, lobed  $1/2$ – $2/3$  towards costa; costules 5–6 mm apart; basal veins meeting at an acute angle at base of sinus-membrane, sometimes without true anastomosis; *lower surface* of costae and rachis glabrous or with few brown hairs; indusia glabrous.

Distr. *Malesia*: Eastern New Guinea, 1750–2000 m.

Note. A specimen from near Bulolo has pinnae to  $24 \times 3.5$  cm, lobed rather more than  $2/3$ , with copious brown hairs on lower surface of rachis and costae. Field study of this and *P. jermyi* is needed to confirm distinctions between them, or possibly to indicate that they should be united.

**26. *Pneumatopteris rodigasiana* (T. MOORE) HOLTUM**, *Blumea* 21 (1973) 319; *Allertonia* 1 (1977) 233. — *Nephrodium rodigasianum* T. MOORE in Linden, Ill. Hort. 29 (1882) 27, pl.

442. — *Thelypteris rodigasiana* (T. MOORE) REED, *Phytologia* 17 (1968) 310. — *Dryopteris transversaria* (BRACK.) C. CHR. var. *rodigasiana* C. CHR. Bishop Mus. Bull. 177 (1943) 88. — Type: cult. LINDEN, ex Herb. T. Moore (K).

*Cyclosorus rotumaensis* ST. JOHN, Occ. Pap. Bish. Mus. 21 (1954) 180. — Type: ST. JOHN 19139, Rotuma I. (BISH; K).

*Caudex* erect; *stipe* 9–18 cm long, pale, minutely hairy. *Lamina* to 100 cm or more long; pinnae thin, lower 6–9 pairs gradually decrescent, lowest less than 1 cm long, none of them either narrowed or auricled at their bases. *Largest pinnae*  $18 \times 2$  cm; base truncate; apex narrowly acuminate; edges lobed  $\frac{1}{2}$  way to costa; lobes slightly falcate with rounded tips, projections at vein-ends slight; costules 4–5.5 mm apart; veins slender, hardly prominent, concolorous, 6–9 pairs, 1 pair anastomosing, next acroscopic vein to sinus-membrane or to margin; *lower surface* of rachis and costae bearing very short erect pale hairs, a few such hairs on costules and veins and some on the surface between veins; *upper surface* of rachis bearing pale hairs 0.5 mm long, shorter hairs on costae, no others. *Sori* a little inframedial; indusia thin, glabrous or with a few hairs in the middle; sporangia bearing capitate hairs. *Chromosomes*:  $n = 36$  (T. G. WALKER).

Distr. Polynesia (Samoa, Niue I.), Melanesia (Solomons, New Hebrides, Rotuma I.), and E. *Malesia*: Papua New Guinea (Admiralty Is., New Ireland).

**27. *Pneumatopteris japonensis* HOLTUM, sp. nov.**

*Pinnae basales redactae* 12-jugatae, superiores 1.5 cm longae, auriculatae; *lamina* 100 cm longa; *pinnae maximae*  $24 \times 2$  cm, *profunde lobatae*, *tenues*; *venae infimae anastomosantes*, *vena communi excurrenti perbrevis*; *pagina inferior inter venas glandulas minutas ferens*; *indusia parva, glabra*. — Type: AET & IDJAN 426, Japen Island, W. New Guinea (SING; K, L).

*Caudex* short, erect or suberect; *stipe* c. 12 cm long, pale, glabrescent, when young covered with scales  $15 \times 3$  mm; base of stipe to first large pinnae 65 cm; *reduced pinnae* 12 pairs, upper ones auricled, uppermost 1.5 cm long with auricle  $4 \times 1$  mm on acroscopic base, narrowed to basiscopic base, lower ones less than 5 mm long, an intermediate pinna c. 8 cm long sometimes present. *Lamina* excluding reduced pinnae more than 100 cm long; pinnae more than 30 pairs, thin, drying pale olivaceous; lower pinnae somewhat narrowed at their bases which are slightly auricled. *Largest pinnae*  $24 \times 2.0$  cm; base truncate; apex with narrow entire cauda  $2.5 \times 0.3$  cm; edges lobed to 1.5 mm from costa; lobes at right angles to costa, separated by broad sinuses, their tips rounded with slight teeth at vein-ends; costules 4–5 mm apart; veins 12–13 pairs, basal pair anastomosing to form a very short vein excurrent to the sinus;

*lower surface* of rachis, costae and costules bearing sparse pale hairs to 1 mm long, between veins sparse short erect acicular hairs and small colourless glands which collapse when dried, surface not pustular; *upper surface* of rachis bearing coarse pale hairs 1 mm long, hairs on costae shorter, minute acicular hairs and glands between veins. *Sori* a little inframedial, lower ones not divergent; indusia small, glabrous; sporangia apparently lacking glands; spores with a fairly broad erose wing and some anastomosing cross-wings.

Distr. *Malesia*: New Guinea (Japen I.), only known from type.

**28. *Pneumatopteris tobaica* HOLTUM**, Blumea 21 (1973) 316. — Type: SURBECK 14, N. Sumatra, S side of Lake Toba, 1900 m (L; BO).

*Stipe* not seen; base of stipe to first large pinna more than 50 cm; *reduced pinnae* 5–6 cm apart, c. 7 × 7 mm, not auricled; *basal normal pinnae* much narrowed towards their bases, not auricled, base of fifth pinna less than 1 cm wide. *Largest pinnae* 24 × 2.8 cm; apex acuminate, serrate to tip; edges lobed to 4 mm from costa; lobes oblong, subtruncate with irregular short teeth at vein-ends; costules 5–5.5 mm apart; veins 11–12 pairs, basal pair anastomosing, rest all to margin; *lower surface* of rachis bearing sparse hairs, of pinnae glabrous apart from a few hairs on sinus-membranes and margin, surface slightly pustular; *upper surface* of costa bearing sparse hairs, rest glabrous. *Sori* inframedial; indusia firm, with a few short hairs; sporangia bearing capitate hairs.

Distr. *Malesia*: N. Sumatra. Known only from type collection.

Note. The Bogor isotype includes a small plant with erect caudex, but it is not certain that this represents the same species as the large frond. The reduced pinnae are only shown by the Leiden specimen; apart from them, the fronds are very like those of *P. longipes*. More collections are needed.

**29. *Pneumatopteris incisa* HOLTUM** Blumea 21 (1973) 317. — Type: ALSTON 16623, Ternate, G. Gamalama (BM).

*Stipe* 15 cm long; base of stipe to first large pinna 50 cm; *reduced pinnae* 7 pairs, subopposite, uppermost 1.5 × 1.0 cm, triangular, base symmetrically truncate, edges crenate, apex blunt, lowest 5–6 mm long and wide. *Lamina* excluding reduced pinnae 70 cm long; pinnae 30 pairs, texture firm; lower pinnae sub-opposite, gradually narrowed towards their bases, base of lowest 10 mm wide, not auricled; middle pinnae with basal 1–2 pairs of lobes somewhat reduced, basal basiscopic lobe usually longer than acroscopic; upper pinnae with cuneate bases. *Largest pinnae* 21 × 2.7 cm; apex acuminate with subentire cauda 2–2.5 cm long; edges lobed to 2.5 mm from costa; lobes slightly falcate, their tips rounded, entire; costules

5 mm apart, at a wide angle to costa; veins to 12 pairs, slender, pale and prominent both sides, basal pair anastomosing, next pair usually both to margin; *lower surface* of rachis sparsely hairy, of costae and costules with short slender pale erect hairs, somewhat longer hairs on veins and sparsely on surface between veins, longer ones on sinus-membrane and margin, surface between veins slightly pustular; *upper surface* of costae with hairs 1 mm long, rest of pinna glabrous. *Sori* inframedial, lower ones not divergent; indusia thin, with slender hairs; sporangia bearing capitate hairs.

Distr. *Malesia*: Moluccas (Ternate: Halmahera, PLEYTE 397).

Ecol. By stream in forest, at 600 m.

**30. *Pneumatopteris psilophylla* HOLTUM**, *sp. nov.*

*Pinnae redactae* 3-jugatae, usque 7 × 5 mm; *pinnae normales steriles* usque 17 × 2.8 cm, 2/3 *costam versus lobatae*, *subtus perfecte glabrae*; *venae* 12-jugatae, *inferiores vel anastomosantes vel ad basin membranae sinus conniventes*, *par sequens latera membranae tegentes*; *pinnae fertiles ignotae*. — Type: JERMY 13741, Sarawak, Gunong Mulu (BM).

*Caudex* erect (collector); *stipe* 10 cm long, pale, basal scales thin, to 8 mm long, 1–2 mm wide at base, small residual ones adherent; base of stipe to first normal pinna 25–30 cm; *reduced pinnae* 3 pairs, uppermost 7 × 5 mm, deltoid with almost symmetrical base, lowest very small; aerophores not elongate on dried specimens but functional on very young fronds which are covered with mucilage (collector). *Lamina* (sterile) 65 cm long; pinnae c. 25 pairs, basal pinnae slightly reduced and narrowed towards their bases in basal 5 cm, base 7–8 mm wide, pinnae above base successively less narrowed, 6 pairs or more with basal 1–2 pairs of lobes reduced. *Largest pinnae* 17 × 2.8 cm; apex acuminate with entire cauda 1.5–2.0 cm long; edges lobed 2/3 towards costa or a little more deeply, lobes slightly falcate, slightly narrowed distally, edges entire, cartilaginous margins well-marked; costules 5 mm apart; veins 12 pairs, slender, slightly prominent both sides, basal pair anastomosing or meeting at the base of the sinus-membrane, second pair passing to the sides of the membrane; *lower surface* quite glabrous; upper surface with sparse short pale hairs on rachis and costae. *Fertile fronds* not known.

Distr. *Malesia*: Borneo (Sarawak: Mt Mulu), only known from type.

Ecol. In humus in limestone crevices at 150 m.

Note. This is related to *P. truncata* but its pinnae are much more deeply lobed; it is probably confined to limestone.

**31. *Pneumatopteris pergamacea* HOLTUM**, Blu-



mea 21 (1973) 315. — Type: JERMY 7877, New Ireland, cult. Hort. Bot. Kew, 123/70, n. 1035 (K).

*Caudex* short-creeping; *stipe* 10 cm long, bearing many rather persistent  $\pm$  spreading scales 6–10  $\times$  1 mm with acicular hairs 0.3 mm long on their dorsal surface; base of stipe to first normal pinna 60 cm; *reduced pinnae* to 15 pairs, uppermost 3.0  $\times$  1.7 cm, subtriangular, base broadly cuneate and almost symmetric, edges lobed, tip acute, lowest c. 6  $\times$  4 mm with base auricled both sides. *Lamina* excluding reduced pinnae 75 cm long, rather thin; pinnae 28 pairs; lowest 3.5 cm wide in the middle, narrowed towards the base which is 1.8 cm wide, not auricled. *Largest pinnae* c. 27  $\times$  3 cm; base broadly cuneate to full width; apex rather abruptly caudate-acuminate, cauda subentire, to 3 cm long; edges lobed 3/5 towards costa; lobes slightly falcate, tips bluntly pointed, margins entire or nearly so; costules 5–5.5 mm apart, at c. 60° to costa; veins 11–12 pairs, concolorous, hardly prominent, basal pair anastomosing to form a short excurrent vein to base of sinus-membrane, next 1–1½ pairs passing to sides of the membrane; *lower surface* of rachis and costae sparsely and minutely hairy (hairs more abundant distally in both cases), a few short hairs on sinus-membranes and margins of lobes, rest glabrous, old fronds distinctly pustular between veins; *upper surface* of rachis bearing pale hairs more than 0.5 mm long and shorter ones, hairs on costae similar, rest of surface of pinnae of large fronds glabrous but acicular hairs present between veins of the small fronds of young plants, also on reduced basal pinnae of mature plants. *Sori* a little inframedial on distal veins, further from costules on lower veins especially near apex of pinna; indusia very small, hidden by mature sporangia, bearing a few short hairs; sporangia lacking glands; spores medium brown, bearing many minute wings.

Distr. *Malesia*: Papua New Guinea (New Ireland), only known from the type.

Ecol. On mossy limestone boulder in forest at 630 m.

**32. *Pneumatopteris sogerensis* (GEPP) HOLTUM**, *Blumea* 21 (1973) 315. — *Dryopteris sogerensis* GEPP, J. Bot. 61 (1923) Suppl. 61. — *Cyclosorus sogerensis* (GEPP) COPEL. Gen. Fil. (1947) 146; Philip. J. Sci. 78 (1951) 450. — *Thelypteris sogerensis* (GEPP) REED, *Phytologia* 17 (1968) 314. — Type: FORBES 446, Sogere, S.E. New Guinea (BM).

*P. laticuneata* HOLTUM, *Blumea* 21 (1973) 312. — Type: JERMY 8044, N.E. New Guinea (BM).

*Caudex* erect; *stipe* 15–30 cm long, pale, glabrous, bearing residual appressed scales; base of stipe to first normal pinna 70 cm or more; *reduced pinnae* c. 6 pairs, gradually decrescent downwards, uppermost c. 4 cm long, 1.5 cm wide at base which is slightly auricled both sides,

crenate or lobed above base, lowest 10  $\times$  5 mm or smaller. *Lamina* to 150 cm long, rather thin; pinnae to more than 40 pairs; lower pinnae narrowed near their bases which are about ½ maximum width. *Largest pinnae* commonly 27  $\times$  2.5–3 cm, on largest fronds 36  $\times$  4.5 cm (fronds often fertile at a much smaller size); base subtruncate; apex acuminate but not narrowly caudate; edges lobed ½ way to costa (less deeply in small plants, up to 2/3 in largest); lobes slightly falcate with slight projections at vein-ends; costules 4–5.5 mm apart, pale and prominent on lower surface; veins to 14 pairs, slender, concolorous, slightly prominent, 1 pair anastomosing and 1 pair to sides of sinus-membrane; *lower surface* entirely glabrous; upper surface rather sparsely hairy on rachis and costae, hairs pale, to 1 mm long. *Sori* inframedial, basal ones not divergent; indusia usually glabrous, rarely with some acicular hairs; sporangia lacking glands; spores pale with many small wings. *Chromosomes*:  $n = 36$  (T. G. WALKER).

Distr. Australia (Queensland and north of New South Wales), Melanesia (Solomon Is.) and *Malesia*: Papua New Guinea (Bismarck Arch.) and Moluccas.

Ecol. In lowland forest, especially near streams; a common species.

Note. *P. laticuneata* was based on a small plant with shallowly lobed pinnae.

**33. *Pneumatopteris micropaleata* HOLTUM**, *Blumea* 21 (1973) 319. — Type: HOLTUM 58, Mt Kinabalu, Sabah, on wet rocks near waterfall, 1800 m (K; SING).

*Caudex* erect; *stipe* 10 cm long, pale, bearing short pale acicular hairs and appressed scales; base of stipe to first large pinna 50 cm; *reduced pinnae* 4–5 pairs, uppermost 1 cm long, 0.9 mm wide at subtruncate base, almost semicircular with projections at vein-ends, lowest 5 mm long. *Lamina* to 100 cm long, texture firm; pinnae c. 30 pairs; 1–2 pairs basal pinnae gradually narrowed in basal 2 cm. *Largest pinnae* 17  $\times$  1.8 cm; base truncate; apex acuminate with entire cauda to 2 cm long; edges lobed a little more than ½ way to costa (basal pinnae lobed 3/5); lobes slightly oblique, not falcate, their apices broadly rounded, projections at vein-ends slight; costules 3–3.5 mm apart on a fertile frond; veins to 11 pairs, slender, concolorous, 1 pair anastomosing or meeting at base of sinus-membrane, next pair to sides of membrane; *lower surface* of rachis bearing rather sparse slender pale hairs 0.2–0.4 mm long, hairs on costae very short, near base only, on costules slender appressed pale hairs 0.5 mm long, small scales (the smallest linear) at first abundant on costae and costules; *upper surface* of rachis covered with slender pale hairs c. 1 mm long, similar shorter hairs on costae and sparse on costules and veins. *Sori* a little inframedial, basal ones not divergent; indusia glabrous; sporangia



bearing small capitate hairs; spores not seen (sporangia immature).

Distr. *Malesia*: Sabah (Mt Kinabalu), known from type only.

Ecol. On wet rocks near waterfall at 1800 m.

**34. *Pneumatopteris truncata* (POIR.) HOLTUM**, *Blumea* 21 (1973) 314. — *Polypodium truncatum* POIR. *Encycl. Meth.* 5 (1804) 534. — *Dryopteris truncata* (POIR.) C. CHR. *Ind. Fil.* (1905) 299, *excl. Polystichum truncatum* GAUD.; v.A.v.R. *Handb.* (1908) 227, *quoad pl. Males.*; BACKER & POSTH. *Varenfl. Java* (1939) 54. — *Cyclosorus truncatus* (POIR.) FARW. *Amer. Midl. Nat.* 12 (1931) 259; CHING, *Bull. Fan Mem. Inst. Biol. Bot.* 8 (1938) 216; HOLTUM, *Rev. Fl. Mal.* 2 (1955) 266, f. 152; COPEL. *Fern Fl. Philip.* (1960) 367. — *Thelypteris truncata* (POIR.) K. IWATS. *Mem. Coll. Sci. Univ. Kyoto B*, 31 (1964) 33. — Type: "Brézil", no collector cited (P).

*Aspidium abortivum* BL. *En. Pl. Jav.* (1828) 154, *incl. var. B (var. C?)*. — *Dryopteris abortiva* (BL.) O. Ktze, *Rev. Gen. Pl.* 2 (1891) 812; v.A.v.R. *Handb.* (1908) 217. — Type: BLUME, W. *Java* (L. n. 908, 337–855).

*Aspidium abruptum* BL. *En. Pl. Jav.* (1828) 154. — Type: KUHLE & VAN HASSELT, W. *Java* (L. n. 908, 337–817).

*Aspidium eusorum* THW. *Enum. Pl. Zeyl.* (1864) 391. — *Nephrodium eusorum* (THW.) BEDD. *Ferns Br. India* (1866) pl. 130. — Type: THWAITES CP 3064, Ceylon (K).

*Dryopteris batavorum* var. *winkleri* ROSENST. *Fedde Rep.* 13 (1914) 217. — Type: J. WINKLER 158a, Sumatra, in terra Batavorum (S-PA).

*Cyclosorus lepidopodus* C. CHR. & TARD. *Notul. Syst.* 7 (1938) 73; *Fl. Gén. I–C.* 7, 2 (1941) 392, f. 45. — *Thelypteris lepidopoda* (C. CHR. & TARD.) REED, *Phytologia* 17 (1968) 287. — Type: EBERHARDT 5252, Tonkin, Bac Kan (BM).

*P. christelloides* HOLTUM, *Blumea* 21 (1973) 311. — Type: CLEMENS 27451, Sabah, Mt Kinabalu, 1000 m (K; BM).

*Nephrodium truncatum sensu* RACIB. *Fl. Btzig* 1 (1898) 190, *non* (Gaud.) PRESL. — **Fig. 11d–f.**

*Caudex* erect; *stipe* 10–30 cm long, pale, glabrous, bearing residual thin appressed scales; base of stipe to first normal pinna 60–85 cm; *reduced pinnae* 6–10 pairs, not opposite, 3–6 cm apart, uppermost c. 1 × 1 cm, not auricled, 1 or 2 intermediate pinnae sometimes present. *Lamina* to 120 cm long, thin but firm; pinnae to 30 pairs or more; several pairs of lower pinnae much narrowed near their bases which are less than 1 cm wide and unlobed for 1–2 cm, not auricled. *Largest pinnae* commonly 20 × 2.5 cm (to 32 × 3.5 cm); base broadly cuneate to truncate; apex acuminate, in broader pinnae rather abruptly; edges lobed c. 1/3 towards costa, less deeply in narrower pinnae; lobes almost at right angles to costa, truncate, always with some teeth at ends of veins; costules

4–5 mm apart; veins to 12 pairs, pale and prominent, 1½–2 pairs anastomosing, 2 pairs to sides of the sinus-membrane where they usually unite to form a distinct vein on each side of the distal part of the membrane, often continuing close to the margin of a pinna-lobe to join higher veins there; *lower surface* of rachis and costae bearing a variable number of short slender erect pale hairs (in Sarawak sometimes quite glabrous), sparse hairs also on costules and veins and sometimes a few between veins where the surface is always pustular; *upper surface* of rachis bearing longer pale hairs, short hairs sparse on costae, minute on costules, sometimes a few between veins near apices of pinna-lobes. *Sori* a little inframedial, lower ones not divergent; indusia thin, glabrous (hairy on two specimens from Mt Kinabalu); sporangia bearing elongate small glands (lacking in some Sarawak specimens); spores with many small wings.

Distr. Ceylon & S. India; N.E. India to S. China; *Western Malesia*, Lesser Sunda Islands and Philippines.

Ecol. Near streams in forest, at 100–1200 m.

Notes. The epithet *truncatum*, as used by 19th century authors, was based on *Polystichum truncatum* GAUD. CHRISTENSEN cited *Polypodium truncatum* POIR. as basionym in *Ind. Fil.* (1905), wrongly placing GAUDICHAUD's name as a synonym. CHING was the first to see and describe POIRET's type, and accepted its origin as Brazil, but there is no species at all like it in S. America, and the specimen closely matches those from Ceylon and Malaya. A plant examined by MANTON in Ceylon was tetraploid. Smaller plants in N. India are diploid and differ in pinna-lobes and larger glands on sporangia (see HOLTUM 1973); plants from G. Mulu, Sarawak, lacking glands on sporangia, are diploid (T. G. WALKER).

The type of *Aspidium abortivum* BL. was a lowland plant and agrees well with specimens from Malaya. The type of *A. abruptum* BL. was a mountain plant, differing in entire pinna-lobes, but among other specimens from Java there is much variation in the shape of pinna-lobes and it does not seem possible to divide the specimens on this character. Existing specimens do not show any possible distinctions in characters of the reduced basal pinnae, or of lower normal pinnae. As with several other species of this family from Java, good new specimens are needed.

The type of *P. christelloides* at Kew lacks the basal pinnae, but these are present on the BM isotype and show that my description of 1973 was inaccurate. The type differs chiefly from typical *P. truncata* in the unusual abundance of short hairs between the veins of both surfaces (but not on all pinnae), also on indusia. Another plant from Mt Kinabalu, cultivated at Kew, is identical. The pubescence is very like that of *Christella*.

Allied species have been described from China,

and need to be critically compared with Malesian specimens.

**35. *Pneumatopteris lawakii* HOLTUM, nom. nov.** — *Polystichum truncatum* GAUD. in Freyc. Voy. Bot. (1827) 332. — *Aspidium truncatum* GAUD. *ibid.* t. 10. — Type: GAUDICHAUD, Rawak (= Lawak) L., W. New Guinea (P; B, FI).

*P. glaberrima* sensu HOLTUM, Blumea 21 (1973) 318, p.p.

Agreeing with *P. truncata* (POIR.) HOLTUM in the peculiar venation (which is well figured by GAUDICHAUD), differing as follows: fronds much smaller, and thinner; largest pinnae  $15 \times 1.8$  cm; veins 6–7 pairs; lower surface quite glabrous; upper reduced pinnae  $2.0 \times 0.9$  cm, lowest 0.5 cm.

Distr. *Malesia*: West New Guinea.

Notes. Known from the type and MCKEE NGF 1940 from Biak Island, from which the details of the reduced pinnae are described (not figured by GAUDICHAUD). The fronds of the type of *P. glaberrima* (RICHARD) are of similar size but the pinna-lobes are different. More specimens are needed from West New Guinea.

**36. *Pneumatopteris michaelis* HOLTUM, Blumea 21 (1973) 313.** — Type: M. G. PRICE 317, Mt Makiling, Luzon, 1050 m (K).

*Caudex* erect; *stipe* of type 17 cm long, minutely hairy; base of stipe to first normal pinna 50 cm; *reduced pinnae* 4–5 pairs, uppermost 1.2 cm long, 0.8 cm wide at truncate base which is symmetric or slightly wider on acroscopic side, margins crenate. *Lamina* excluding reduced pinnae 60 cm long; pinnae 20 pairs or more, rather close together, texture firm; basal pinnae narrowed towards their bases which are 8 mm wide, narrowed part very shallowly lobed. *Largest pinnae* 22 cm long, 1.5–1.9 cm wide; base broadly cuneate; apex evenly attenuate, apical 2–2.5 cm subentire; edges lobed c. 1/3 towards costa; lobes oblique, strongly truncate with broad teeth at vein-ends and an acute forward-pointing tip; costules 4–5 mm apart; veins 7–8 pairs, slender, concolorous, slightly prominent,  $\frac{1}{2}$  pairs anastomosing, 1 pair to sides of sinus-membrane; lower surface quite glabrous including sinus-membranes and margin, surface between veins slightly pustular; *upper surface* of rachis and costae rather sparsely hairy, hairs pale, 0.5 mm long. *Sori* inframedial on distal veins, supramedial on basal ones, those on basal veins from adjacent costules sometimes confluent; indusia thin, glabrous; sporangia lacking glands; spores pale with a moderate number of distinctly flat small wings.

Distr. *Malesia*: Philippines (Luzon: Mt Makiling), 2 collections.

Note. Plants have been cultivated at Kew, and have remained very distinct from a plant of *P. truncata* from Mt Kinabalu both in size of plant

and shape of pinnae, and also in requiring a cooler temperature for good growth.

**37. *Pneumatopteris nitidula* (PRESL) HOLTUM, Blumea 21 (1973) 318.** — *Nephrodium nitidulum* PRESL, Epim. Bot. (1851) 46; HOLTUM, Novit. Bot. Univ. Carol. Prag. 1968 (1969) 40. — *Cyclosorus nitidulus* (PRESL) COPEL. Fern Fl. Philip. (1960) 364, p.p. excl. syn. omn. — *Thelypteris nitidula* (PRESL) REED, Phytologia 17 (1968) 296. — Type: CUMING s.n., Philippines (PRC).

*Caudex* short, erect; *stipe* c. 10 cm long, pale, bearing thin appressed scales; base of stipe to first large pinna 30–40 cm; *reduced pinnae* to 7 pairs, basal ones  $7 \times 7$  mm, almost orbicular, uppermost 2.5–3.0 cm long, 1.5 cm or more wide, base truncate, auricled or dilated both sides, distal part lobed. *Lamina* excluding reduced pinnae to 100 cm long; pinnae to 30 pairs or more, thin, spreading at a wide angle to rachis; basal pinnae not or little narrowed at their bases. *Largest pinnae* of type  $24 \times 2.2$  cm (largest seen 34 cm long); base truncate; apex almost evenly attenuate, narrow subentire distal part 2 cm or more long; edges lobed less than  $\frac{1}{2}$  way to costa on small fronds, more than  $\frac{1}{2}$  on type; lobes slightly oblique, their apices almost rounded on largest pinnae, subtruncate on smaller ones, projections at vein-ends slight or lacking, cartilaginous margins narrow; costules 4.5–5.5 mm apart; veins 8–10 pairs, slender, concolorous, basal pair anastomosing, next acroscopic vein to side of short sinus-membrane; *lower surface* of rachis and costae bearing minute erect hairs, similar hairs also  $\pm$  abundant on other parts, surface between veins often not pustular; hairs on *upper surface* of rachis and costae sparse, pale, short. *Sori* inframedial, basal ones not divergent; indusia bearing few to many acicular hairs; sporangia with many rather large club-shaped glands; spores light brown with many very small wings.

Distr. *Malesia*: Philippines (Luzon to Mindanao).

Ecol. A common species at low altitudes, often near streams, sometimes in rather open places.

**38. *Pneumatopteris kerintjiensis* HOLTUM, Blumea 21 (1973) 312.** — Type: ALSTON 14149, Sumatra, Sungei Kering, Kerintji (BM).

*Dryopteris sumatrana* sensu TROLL, Flora 128 (1933) 329–337.

*Stipe* 5 cm long; base of stipe to first large pinna 75 cm; *reduced pinnae* at least 10 pairs, uppermost to  $3.5 \times 3.5$  cm, almost symmetrically triangular with shallowly lobed edges and blunt tip, lowest  $2 \times 2$  cm. *Lamina* excluding reduced pinnae 120 cm long; pinnae 45–50 pairs; basal pinnae not or little narrowed towards their bases which are almost symmetrically dilated; texture firm. *Largest pinnae*  $25 \times 2.5$  cm; base truncate; apex acuminate, not caudate; edges lobed 1/3–2/5 towards

costa; lobes not falcate, entire with rounded tips; costules 4.5 mm apart, at a wide angle to costa; veins to 12 pairs, hardly prominent either side, 2 pairs anastomosing, next  $1\frac{1}{2}$  pairs to sides of sinus-membrane; minute hairs present on lower surface of costae, costules and veins, surface between veins strongly pustular; upper surface of costae bearing short hairs, rest of pinnae glabrous. Sori a little inframedial, lower ones not divergent; indusia thin, glabrous; sporangia bearing capitate hairs; spores light brown with many small wings.

Distr. *Malesia*: North-central Sumatra.

Ecol. In forest at 1150–1400 m; the type found in a tea estate.

Note. TROLL's photograph and his data about mucilage hairs on scales clearly indicate the present species. He refers to BEDDOME's description of the reduced basal pinnae of *Nephrodium molle* var. *major*, but that description refers to *Christella papilio*, q.v.

**39. *Pneumatopteris nephrolepioides*** (C. CHR.) HOLTUM, *Blumea* 21 (1973) 320. — *Dryopteris nephrolepioides* C. CHR. Brittonia 2 (1937) 268, f. 1, c, d. — *Thelypteris nephrolepioides* (C. CHR.) REED, *Phytologia* 17 (1968) 295. — Type: BRASS 5354, Mafulu, Central div. Papua, on limestone 1700 m (BM; NY).

*Caudex* short; *stipe* 3–4 cm long, slender, glabrous, scales ovate, 1 mm long. *Lamina* to 40 cm long; pinnae c. 40 pairs; lower pinnae gradually reduced and more widely spaced, lowest 2 mm long; texture firm, drying light green. *Largest pinnae* 1.8 × 0.6 cm; base truncate to subcordate, slightly auricled on acroscopic and rounded on basiscopic side; apex rounded; edges slightly sinuous to almost crenate; small hydatodes each with a white scale near ends of veins, just within the margin; veins 7–8 pairs in each pinna, oblique, simple except the forked basal acroscopic one, free, slightly prominent on upper surface; lower surface of rachis bearing short acicular hairs, sparse minute capitate hairs present on costa and veins; upper surface of rachis copiously hairy, very short erect acicular hairs also present on whole upper surface of pinnae. Sori medial on veins, small, exindusiate; sporangia bearing very small capitate hairs (sometimes 3); spores light brown with many small wings.

Distr. *Malesia*: Papua New Guinea. Only known from type.

Ecol. On limestone, at 1700 m.

**40. *Pneumatopteris ligulata*** (PRESL) HOLTUM, *Blumea* 21 (1973) 320. — *Lastrea ligulata* PRESL, *Epim. Bot.* (1851) 35; COPEL. *Fern Fl. Philip.* (1960) 327. — *Dryopteris ligulata* (PRESL) O. KTZE, *Rev. Gen. Pl.* 2 (1891) 813; v.A.v.R. *Handb.* (1908) 184. — *Thelypteris ligulata* (PRESL) CHING, *Bull. Fan Mem. Inst. Biol. Bot.* 10 (1941) 252. — Type: CUMING 74, Luzon (PRC; E, K).

*Lastrea philippina* PRESL, *Epim. Bot.* (1851) 36. — Type: CUMING 343, Zebu (PRC).

*Nephrodium luerssenii* HARR. *J. Linn. Soc. Bot.* 16 (1877) 29. — *Dryopteris luerssenii* (HARR.) C. CHR. *Ind. Fil.* (1905) 276; v.A.v.R. *Handb.* (1908) 190. — Type: STEERE s.n. Bulukai Isl. (K).

*Dryopteris immersa* var. *ligulata* CHRIST, *Philip. J. Sci.* 2 (1907) Bot. 208. — Type: CUMING 343, Zebu (P).

*Dryopteris foxii* CHRIST, *Philip. J. Sci.* 2 (1907) Bot. 208; v.A.v.R. *Handb.* (1908) 814. — *Lastrea foxii* (CHRIST) COPEL. *Fern Fl. Philip.* (1960) 328. — *Thelypteris foxii* (CHRIST) REED, *Phytologia* 17 (1968) 277. — Lectotype (HOLTUM 1973): COPELAND 940, Mindanao (US).

*Caudex* short-creeping; *stipe* pale or ± flushed reddish, to 40 cm long, scales near base to 5 × 1 mm bearing many short acicular hairs on outer surface. *Lamina* very variable, in largest plants 70 cm or more long with c. 20 pairs of well-spaced and oblique pinnae, basal pinnae of large fronds commonly about half length of largest, sometimes a smaller, more widely-spaced pair also; smaller plants have fertile fronds 25 cm long, three pairs lower pinnae gradually reduced and more widely spaced, lowest 1 cm long. *Pinnae of large fronds* to 23 × 3 cm; base unequally broadly cuneate with acroscopic lobe longer than basiscopic; apex caudate-acuminate; edges lobed to 0.5 mm from costa or more deeply; lobes 2.5–3 mm wide, oblique, sometimes slightly toothed at ends of veins, widened a little above the base, apices broadly pointed; sinuses between lobes broad with rounded base and very small sinus-membranes; costules 5 mm apart, at 45° to costa; veins to 12 pairs, slender, pale, prominent both sides; lower surface of rachis glabrous, of costae, costules, veins and surface between veins bearing a variable number of slender erect hairs, a few longer hairs sometimes present on costules and veins, surface between veins finely pustular; upper surface of costae with pale hairs 0.5 mm long, rest of surface bearing very short erect pale hairs. Sori suprasedial; indusia thin with short capitate hairs and sometimes acicular hairs; sporangia bearing capitate hairs. *Pinnae of small fertile fronds* c. 10 × 1.5 cm; lobes 2 mm wide; costules 4 mm apart; veins to 9 pairs; sori sometimes almost medial; indusia usually lacking acicular hairs.

Distr. *Malesia*: Philippines (Luzon to Mindanao) and N. Moluccas (Talaud Is.).

Ecol. The smaller plants mostly on rocky stream-banks (once on the bank of a rice-paddy), the larger ones in forest, at low and medium altitudes.

Notes. As reported by CHRIST (1907) COPELAND at first distinguished *D. foxii* by its small fronds, much-reduced basal pinnae and almost medial sori, but in all these characters there is no sharp distinction (and the largest fronds in herbaria usually lack the base, so that smaller

basal pinnae might have been present). I suggest that the distinction is one of habitat (as with stream-bank forms of *Pronephrium menisciicarpum*). Middle pinnae of large fronds are similar in aspect to those of *Amphineuron immersum* (BL.) HOLTUM, but differ from the latter in very oblique widely-spaced lobes, in venation and in glandular hairs.

**41. *Pneumatopteris finisterrae* (BRAUSE) HOLTUM, comb. nov.** — *Dryopteris finisterrae* BRAUSE, Bot. Jahrb. 49 (1912) 20. — *Lastrea finisterrae* (BRAUSE) COPEL. Gen. Fil. (1947) 138; Philip. J. Sci. 78 (1951) 426. — *Thelypteris finisterrae* (BRAUSE) REED, Phytologia 17 (1968) 277. — Type: SCHLECHTER 18134, N.E. New Guinea, Finisterre Mts (B; P).

*Caudex* erect; *stipe* densely short-hairy, basal scales broad, appressed; base of *stipe* to first normal pinna 35 cm or more; *reduced pinnae* 5–6 pairs, all less than 2 mm long. *Lamina* excluding *reduced pinnae* to 40 cm long; pinnae to 18 pairs, thin, basal pinnae not distinctive. *Largest pinnae* 7.5 × 0.9 cm; base unequally broadly cuneate; apex acuminate; edges lobed to 0.5 mm from costa; lobes at 45° to costa, their tips rounded, entire or at most slightly crenate; costules 3 mm apart; veins 4–6 pairs, oblique, hardly prominent, basal ones both ending at margin above base of sinus; *lower surface* bearing short erect pale acicular hairs on all parts, also short capitate hairs or small sessile glands; *upper surface* of rachis and costae bearing short antrorse hairs, whole surface of pinna bearing short erect acicular hairs. *Sori* medial; indusia small, thin, long-hairy; sporangia bearing short slender setae; spores with a rather broad entire translucent wing and a few anastomosing cross-wings.

Distr. *Malesia*: N.E. New Guinea (3 collections).

Note. This appears to be allied to *P. costata*. It is aberrant in the slender setae on sporangia, and needs further study.

**42. *Pneumatopteris versteeghii* HOLTUM, Blumea 21 (1973) 321.** — Type: VERSTEEGH BW 10259, W. New Guinea, Genifa Mts (L).

*Caudex* short-creeping, 2 mm diameter, stipes closely seriate on it; *stipe* 8 cm long, slender, pale, scales very small and appressed. *Lamina* 15–18 cm long; pinnae to 20 pairs; basal pinnae somewhat reduced, at least half as long as the next pair; texture firm but translucent, light olivaceous when dried. *Largest pinnae* 2 × 0.6 cm; base very asymmetric, on basiscopic side very narrowly cuneate, on acroscopic side truncate with a dentate auricle 5–6 mm long; apex obtuse; in middle lobed half-way to costa; lobes sometimes dentate at vein-ends; veins in basal auricle 4 pairs, in middle lobes 2 pairs, basal acroscopic vein passing to base of sinus, basiscopic vein to

margin; *lower surfaces* quite glabrous; *upper surface* with short hairs on rachis and a few on bases of costae. *Sori* on basal acroscopic vein of each group; indusia short-hairy; sporangia with capitate hairs.

Distr. *Malesia*: West New Guinea. Only known from the type.

Ecol. In forest on steep rocky soil at 1100 m.

**43. *Pneumatopteris sumbawensis* (C. CHR.) HOLTUM, Blumea 21 (1973) 323.** — *Dryopteris sumbawensis* C. CHR. in Rensch, Hedwigia 74 (1934) 231, t. vii, f. 1. — Type: RENSCH 578, Sumbawa, Batu Dulang (B; BO).

*Caudex* unknown; *stipe* 2–3 cm long. *Lamina* 30 cm long; pinnae 35–40 pairs; 6 pairs lower pinnae gradually or subabruptly reduced, lowest 3 mm long; lower large pinnae a little narrowed to their bases on basiscopic side; texture thin, drying pale olivaceous. *Largest pinnae* 3.0 × 1.0 cm, sub-pinnate with basal acroscopic lobe quite free and 2–3 pairs of lobes separately adnate to costa, rest deeply lobed, apex abruptly narrowed to a blunt tip; costules to 3 mm apart; veins free, 3–4 pairs, dark but not prominent beneath, basal acroscopic one sometimes forked; *lower surface* of rachis and costae bearing minute capitate hairs and very short acicular ones, short capitate hairs present all over lower surface of pinnae as in *P. costata*; hairs on *upper surface* of rachis 0.3 mm long, shorter on costae, rest of pinna with sparse very short acicular and capitate hairs. *Sori* medial to supramedial, exindusiate; neither glands nor setae on sporangia.

Distr. *Malesia*: Lesser Sunda Is. (Sumbawa), only known from type.

Note. This is related to *P. costata* which also occurs on Sumbawa, but has very different pinnae.

**44. *Pneumatopteris keysseriana* (ROSENST.) HOLTUM, Blumea 21 (1973) 320.** — *Dryopteris keysseriana* ROSENST. Fedde Rep. 10 (Feb. 1912) 333; v.A.v.R. Handb. Suppl. (1917) 157. — *Lastrea keysseriana* (ROSENST.) COPEL. Gen. Fil. (1947) 139; Philip. J. Sci. 78 (1951) 430. — *Thelypteris keysseriana* (ROSENST.) REED, Phytologia 17 (1968) 286. — Type: KEYSER 253, N.E. New Guinea, Sattelberg (not seen).

*Dryopteris schultzei* BRAUSE, Bot. Jahrb. 49 (August 1912) 19; v.A.v.R. Handb. Suppl. (1917) 156. — Type: L. SCHULTZE 253, Sepik District (B). — Fig. 11i–j.

*Caudex* short-creeping with tufted stipes; *stipe* to 70 cm long, pale except base, scales thin, appressed; *reduced basal pinnae* commonly 2–3 pairs, much smaller than normal ones, in one specimen apparently 8 pairs. *Lamina* to 100 cm long; normal pinnae 20 pairs or more; basal pinnae variably narrowed towards their bases, narrower on basiscopic side where the basal lobe is obsolete

or very small. *Largest pinnae* c.  $25 \times 4$  cm (ROSENSTOCK reports 6 cm wide); base unequally broadly cuneate, basal basiscopic lobe shorter than acroscopic; apex acuminate with cauda 3–4 mm long; edges lobed to 1–2 mm from costa with wide sinuses between lobes; lobes slightly tapering, tips rounded to bluntly pointed, edges near tips slightly crenate at vein-ends; costules 5–6 mm apart, at a wide angle to costa; veins to 16 pairs, pale and prominent both sides, basal pair ending at margin near together, at least in distal part of pinna; *lower surface* of rachis bearing very short hairs, similar hairs variably present on lower surface of pinnae, surface between veins slightly pustular; *upper surface* of costae bearing short pale hairs, rest of pinna glabrous. *Sori* supramedial; indusia small with short hairs; sporangia sometimes with capitate hairs; spores with many small wings. *Chromosomes*:  $n = 36$  (T. G. WALKER).

Distr. *Malesia*: Eastern New Guinea.

Ecol. By streams in lowland forest and to 1000 m, common.

Note. Specimens from the type locality, named by ROSENSTOCK, have been seen. The type of *Dryopteris schultzei* differs chiefly in a greater abundance of hairs on the lower surface, some of them between veins.

**45. *Pneumatopteris caudata* (HOLTUM) HOLTUM**, *Blumea* 21 (1973) 321. — *Pseudocyclosorus caudatus* HOLTUM, *Blumea* 13 (1965) 133. — Type: cult. Hort. Bot. Kew. 545/63, n. 12, origin near Lae, N.E. New Guinea (K).

*Caudex* erect; *stipe* pale, basal scales small, ovate; base of stipe to first normal pinna 15 cm or more; reduced pinnae 2 pairs, 2–3 mm long. *Lamina* excluding reduced pinnae 30 cm long; pinnae 15 pairs; lower pinnae narrowed both sides towards their bases. *Largest pinnae*  $8 \times 1.5$  cm; base strongly asymmetric with minute basal basiscopic lobe, basal acroscopic lobe almost free and not reduced; apex abruptly narrowed to a cauda 2.5 cm long, 2 mm wide; edges lobed to 1 mm from costa; lobes at  $45^\circ$  to costa, entire or slightly toothed at vein-ends, apices rounded; costules 3.5 mm apart; veins 9 pairs, oblique, pale and prominent on lower surface, basal acroscopic vein ending at sinus, basiscopic at margin above base of sinus; *lower surface* of rachis, costae and costules bearing minute acicular hairs, short capitate hairs on costules and veins, surface between veins slightly pustular; *upper surface* hairy on rachis and costae only. *Sori* supramedial; indusia short-hairy; no glands seen on sporangia; spores pale with many small wings. *Chromosomes*:  $n = 36$  (S. K. ROY 1965).

Distr. *Malesia*: Papua New Guinea. Only known from the type.

Note. This is certainly nearly allied to *P. keyseriana* and from a neighbouring locality, but

plants of the two cultivated at Kew remained very distinct.

**46. *Pneumatopteris deficiens* HOLTUM**, *Blumea* 21 (1973) 321. — Type: POSTHUMUS 3183, Flores (BO; K).

*Caudex* short, erect; *stipe* to 40 cm long, pale, glabrous, covered with thin small scales when young. *Lamina* c. 35 cm long; free pinnae 8 pairs, texture firm; basal pair of pinnae  $\pm$  reduced, in most cases only 5 mm long; basal large pinnae narrowed evenly towards their bases. *Largest pinnae*  $12 \times 2.2$  cm; base unequally cuneate; apex acuminate, dentate to tip; edges lobed to 1 mm from costa; lobes oblique, acute, edges with slight teeth at ends of veins; costules 5–6 mm apart; veins to 8 pairs, pale and prominent on both sides, basal acroscopic vein ending beside the short sinus-membrane, basiscopic vein to margin above base of sinus; *lower surface* of costae sometimes with minute acicular hairs, short hairs present on margins of lobes, surface between veins slightly pustular; *upper surface* hairy on costae, rest of pinna glabrous. *Sori* a little inframedial; indusia with a few very short hairs; no glands seen on sporangia.

Distr. *Malesia*: Lesser Sunda Is. (Flores), several collections.

Ecol. At 1300 m, on moist banks of earth in wet shady ravines.

**47. *Pneumatopteris mingendensis* (GILLI) HOLTUM**, *comb. nov.* — *Lastrea mingendensis* GILLI, *Ann. Nat. Hist. Mus. Wien* 81 (1978) 24. — Type: GILLI 265, N.E. New Guinea, Chimbu District (W).

*Stipe* 15 cm long, pale, glabrous except in groove; base of stipe to first normal pinna 30 cm; reduced pinnae 2 pairs, widely spaced, upper ones 2 cm long with basal auricle 7 mm long, lower ones 7 mm long with auricle 4 mm. *Lamina* excluding reduced pinnae 60 cm long; basal normal pinnae somewhat reduced. *Largest pinnae*  $13 \times 3$  cm, lobed to less than 1 mm from costa, lobes on basiscopic side shorter and more oblique than on acroscopic, basal acroscopic lobe 2.0 cm long, basal basiscopic lobe much shorter and 10 mm from base of pinna; apex narrowly caudate, cauda 2–2.5 cm long; costules 5–6 mm apart; veins 10–12 pairs, pale and prominent both sides, basal veins ending far apart at the margin; *lower surface* of rachis and costae bearing many acicular hairs hardly 0.1 mm long, sparse similar hairs on costules, surface between veins not distinctly pustular; *upper surface* of rachis and costae bearing hairs a little longer than those on lower surface, no other hairs present. *Sori* medial; indusia small, glabrous; capitate hairs present on some sporangia; spores pale with many wings of irregular shape.

Distr. *Malesia*: Papua New Guinea. Only known from the type.

Ecol. At 2100 m in *Pandanus* forest.

Note. GILLI reported that indusia are absent, but though small they are certainly present.

**48. *Pneumatopteris eburnea* HOLTUM, sp. nov.**

*Lamina* usque 35 cm longa; *pinnae* usque 18-jugatae, rigidae, maximae 6.5 × 1.6 cm, infimae leviter redactae, inferiores plurijugatae basin versus angustatae, omnes profunde lobatae; venae liberae, subtus crassae, prominentes, pallidae; pagina inferior perfecte glabra; indusia parva, glabra. — Type: JERMY 14132, Sarawak, Gunong Mulu, 1500–1600 m (BM).

*Caudex* short-creeping; *stipe* 20–40 cm long, pale above base, glabrous, basal scales broad, thin, not persistent; *reduced pinnae* lacking. *Lamina* to 35 cm long; *pinnae* to 18 pairs, rigid and brittle when dry; basal *pinnae* slightly reduced, much narrowed towards their bases on basiscopic side, less so on acroscopic side which is slightly auricled; several successive pairs of *pinnae* less narrowed at their bases. *Largest pinnae* 6.5 × 1.6 cm, sessile, aerophores not elongate; apex short-acuminate; edges lobed to 1.5 mm from costa, lobes hardly falcate, their tips rounded, edges thickened; costules to 3 mm apart, almost at right angles to costa; veins to 10 pairs, all very oblique, thick, pale and prominent on lower surface, concolorous on upper, basal veins both ending just above base of sinus, sinus-membrane not evident; *lower surfaces* quite glabrous, often with residual narrow scales; *upper surface* of rachis with sparse hairs 0.3 mm long, many hairs 0.4–0.5 mm long on edges of costal groove, no other hairs. *Sori* medial; indusia small, thin but firm, glabrous; sporangia lacking glands, a hair of 3 cells sometimes present on stalks of sporangia; spores pale with many small wings.

Distr. *Malesia*: Borneo (Sarawak: Mt Mulu), known only from type.

Ecol. In gullies on limestone at 1500–1600 m.

**49. *Pneumatopteris excisa* (HOLTUM) HOLTUM, Blumea 21 (1973) 321. — *Pseudocyclosorus excisus* HOLTUM, Blumea 13 (1965) 133. — Type: MILLAR & HOLTUM NGF 18623, N.E. New Guinea, Eastern Highlands (K; LAE, L).**

*Caudex* erect; base of *stipe* to first normal pinna 25 cm; *reduced pinnae* 2–3 pairs, very small, remote from basal normal pinna. *Lamina* to 40 cm long; *pinnae* to 25 pairs; texture firm. *Largest pinnae* of type 10 × 1.5 cm, of another collection 19 × 3 cm, lobed to less than 0.5 mm from costa, lobes with rounded tips and distinct teeth at vein-ends, several lobes reduced near base of pinna especially on basiscopic side, basal acroscopic lobe not free; apex of pinna caudate-acuminate, cauda 2.5 cm long, crenate; costules 3 mm apart; veins of type 8 pairs, pale and prominent both sides, basal veins usually both ending at margin above base of sinus; *lower surface* of rachis and

costae bearing very short acicular hairs, scattered similar hairs on costules and a few short capitate ones, surface between veins slightly pustular, glabrous; *upper surface* short-hairy on costae, a few hairs present on costules and veins. *Sori* medial, filling lower surface at maturity; indusia minute, glabrous; no glands seen on sporangia; spores with many very small wings.

Distr. *Malesia*: N.E. New Guinea, several collections at 1300–2000 m.

**50. *Pneumatopteris regis* (COPEL.) HOLTUM, Blumea 21 (1973) 322. — *Dryopteris regis* COPEL. Univ. Cal. Publ. Bot. 18 (1942) 220. — *Lastrea regis* COPEL. Philip. J. Sci. 78 (1951) 425, pl. 19. — *Thelypteris regis* (COPEL.) REED, Phytologia 17 (1968) 308. — Type: C. KING 486, Papua, mountains behind Wedan (MICH).**

*Stipe* not seen. *Lamina* 120 cm long including 6 pairs of deeply lobed basal *pinnae* 1–1.5 cm long and wide; texture firm. *Largest pinnae* 15 × 2.5 cm; base truncate, a little dilated, wider on acroscopic side; apex acuminate; edges lobed to 1 mm from costa; lobes 13 × 4 mm, entire, ends rounded; costules 5 mm apart, at more than 60° to costa; veins 8 pairs, oblique, basal veins both ending at the margin above base of sinus; *lower surface* glabrous; *upper surface* of *pinnae* glabrous apart from many dark brown hairs on costae, hairs on rachis pale. *Sori* small, inframedial; indusia apparently absent (all sori are old, and indusia might have fallen); no glands seen on the few remaining sporangia; spores not seen.

Distr. *Malesia*: Papua New Guinea. Only known from the type.

**51. *Pneumatopteris boridensis* HOLTUM, sp. nov.**

*Pinnae basales redactae* 6-jugatae, alternae, suprema 3 × 1.3 cm, infima 0.9 cm longa; *pinnae normales* 17 × 2.3 cm, fertiles 2/3 costam versus lobatae; venae 9–10-jugatae, infimae ambae membranam sinus tangentes vel in pinnis sterilibus infra sinum junctae; indusia magna, tenuia, hirsuta. — Type: FOREMAN & VINAS LAE 60262, S.E. New Guinea, Port Moresby Subdistr., near Boridi village (K).

*Caudex* short-creeping; *stipe* 22 cm long, pale, glabrous; base of *stipe* to first normal pinna 55 cm; *reduced pinnae* 6 pairs, alternate, lowest 9 mm long and distinctly auricled, uppermost 3 × 1.3 cm with slight basal auricle. *Lamina* excluding reduced *pinnae* 70 cm long, texture thin; basal *pinnae* neither narrowed towards their bases nor auricled. *Largest fertile pinnae* 17 × 2.3 cm (sterile 2.5 cm wide at base); base very broadly cuneate; apex caudate-acuminate, cauda to 3 cm long, crenate; edges lobed to 3.5–4 mm from costa in fertile *pinnae*, less deeply in sterile; lobes slightly toothed at vein-ends especially where fertile; costules 5 mm apart; veins 9–10 pairs, lowest pair on fertile *pinnae* just touching base of the short

sinus-membrane, on fertile pinnae sometimes uniting below the membrane; *lower surface* glabrous; *upper surface* of rachis bearing pale hairs more than 0.5 mm long, shorter ones on costae, no others. *Sori* inframedial, basal ones not divergent; indusia large, thin, shrivelling when old, bearing in the middle many slender hairs 0.5 mm long; no glands seen on sporangia.

Distr. *Malesia*: Papua New Guinea, only known from the type.

Ecol. By stream at 1190 m.

**52. *Pneumatopteris imbricata* HOLTUM**, *Blumea* 21 (1973) 322. — Type: BROOKS 17775, Amboina, Hila, 200 m, on rock by river (BM; BO, L).

*Caudex* "short and stumpy" (Womersley & Whitmore); *stipe* 5 cm long, basal scales thin, 2 mm wide at base; base of *stipe* to first normal pinna 45–60 cm; *reduced pinnae* many pairs, 1 cm long, deeply lobed, both basal lobes large and lobed. *Lamina* to 110 cm long, thin, translucent; pinnae 35 pairs, all opposite; basal normal pinnae with enlarged dentate basal lobes, the acroscopic lobe (when dried in a press) overlapping the lower surface of the rachis, basiscopic lobe overlapping the upper surface. *Largest pinnae* 24 × 3.0 cm; base truncate, ± auricled on the acroscopic side; apex narrowly acuminate, serrate to the tip; edges lobed to 1 mm from costa, sinuses between lobes wide, rounded at their bases; lobes oblong, oblique, slightly falcate, their tips broadly rounded, entire, little over 3 mm wide when dried; costules 4.5–5.5 mm apart; veins to 12 pairs, basal ones both to margin above base of the sinus; *lower surfaces* glabrous apart from a few short hairs distally on costae and on sinus-membranes and margin; *upper surface* densely brown-hairy on rachis and costae, rest glabrous. *Sori* small, somewhat inframedial, somewhat impressed on upper surface, exindusiate; sporangia of Guadalcanal specimen bearing short yellow capitate hairs; spores with a rather narrow median wing and some cross-wings.

Distr. Solomon Is. (Guadalcanal) and *E. Malesia*: Moluccas (Halmahera & Amboina).

Note. The *sori* of the type are young and the sporangia do not show glands; The Halmahera specimen (PLEYTE 370) has old *sori* with shrivelled glands on sporangia. The Guadalcanal specimen (WOMERSLEY & WHITMORE BSIP 1038) is a little smaller than the type but otherwise closely similar.

**53. *Pneumatopteris petrophila* (COPEL.) HOLTUM**, *Blumea* 21 (1973) 322. — *Dryopteris petrophila* COPEL. Univ. Cal. Publ. Bot. 18 (1942) 220. — *Lastrea petrophila* COPEL. Philip. J. Sci. 78 (1951) 424, pl. 18. — *Pseudocyclosorus petrophilus* (COPEL.) HOLTUM, *Blumea* 13 (1965) 133. — *Thelypteris petrophila* (COPEL.) REED, *Phytologia* 17 (1968) 303. — Type: BRASS 11326, W.

New Guinea, Bele River (MICH; BM, L).

*Caudex* short, erect; *stipe* 4–6 cm long, pale, minutely hairy, basal scales small, appressed. *Lamina* 40 cm long, texture very firm; pinnae c. 20 pairs, almost opposite, lower 8–10 pairs reduced, rather abruptly and then gradually, lowest 3 × 3 mm, intermediate pinnae lobed and distinctly auricled on the acroscopic base. *Largest pinnae* of type 4 cm long, 8–9 mm wide above base (other specimens to 9 × 1 cm); base subtruncate and ± auricled on acroscopic side, narrower and rounded on basiscopic; apex short-pointed (acuminate on larger specimens); edges lobed 1/2 towards costa; lobes falcate, narrowed a little to blunt tips, entire; costules 3 mm apart, oblique; veins 3–5 pairs, slender and prominent, basal acroscopic vein ending beside sinus-membrane, basiscopic one at margin above base of sinus; *lower surface* of rachis copiously short-hairy, minute acicular and capitate hairs on costae, costules and veins, surface between veins pustular and bearing minute capitate hairs; *upper surface* of costae short-hairy (hairs brown on larger specimens), sparse short hairs present between veins. *Sori* medial or inframedial, exindusiate; sporangia bearing small colourless capitate hairs; spores pale with many small wings. *Chromosomes*:  $n = 36$  (T. G. WALKER).

Distr. *Malesia*: New Guinea. Besides type, several collections in N.E. New Guinea.

Ecol. On wet rocks at c. 2000 m.

Note. This is related to *P. latisquamata*; I found both near Edie Creek.

**54. *Pneumatopteris walkeri* HOLTUM**, *Blumea* 21 (1973) 323. — Type: T. G. WALKER 9980, N.E. New Guinea, Eastern Highlands, Waisa (BM).

*Caudex* short, erect or suberect; *stipe* 20 cm long, pale, minutely hairy, basal scales thin, appressed; base of *stipe* to first normal pinna 45–50 cm; *reduced pinnae* 6–8 pairs, 2–3 mm long, with 1–2 pairs transitional to normal pinnae. *Lamina* 55 cm long, excluding reduced pinnae; pinnae 20 pairs; texture thin, drying pale olivaceous. *Largest pinnae* 11 × 1.9 cm; base asymmetric, truncate on acroscopic side, narrowly cuneate on basiscopic side with reduced basal lobe; apex caudate-acuminate, cauda 3 cm long, serrate; edges lobed to 0.5 mm from costa; lobes on acroscopic side of pinna longer than on basiscopic and almost at right angles to costa, lobes on basiscopic side at 45°, all lobes ± dentate near apices; costules 4 mm apart; veins in acroscopic lobes to 9 pairs, in basiscopic lobes sometimes fewer, prominent both sides, pale beneath, basal veins both running to margin above base of sinus; *lower surface* of rachis bearing copious minute acicular hairs, rest glabrous, pustular between veins; *upper surface* with short hairs on rachis and costae only. *Sori* medial; indusia thin, glabrous; no glands seen on sporangia.

Distr. *Malesia*: Papua New Guinea. Only known from the type.

Doubtful

*Aspidium glaberrimum* RICHARD, Sert. Astrolab. (1834) xviii. — Type: D'URVILLE, Prt Dorei, N.W. New Guinea (P).

There is a photograph at BM of the type, but I did not find the specimen at Paris. I saw another specimen so named, collected by D'URVILLE in

New Ireland in 1827. Both specimens differ from the type of *Polystichum truncatum* GAUD. in having entire pinna-lobes. They are very like small plants of *Pneumatopteris sogerensis* but the specimen from New Ireland has capitate hairs on the sporangia. A specimen from the Markham Valley, N.E. New Guinea (WAKEFIELD 1505, BM) is about the same size as the type and has rather large club-shaped glands on the sporangia, but has also rather numerous short hairs on all parts of the lower surface of pinnae.

## 17. SPHAEROSTEPHANOS

J. SM. in Hook. Gen. Fil. (1839) t. 24; COPEL. Univ. Cal. Publ. Bot. 16 (1929) 60; CHING, Sunyatsenia 5 (1940) 240; COPEL. Gen. Fil. (1947) 144; *emend.* HOLTUM, Blumea 19 (1971) 39; Kalikasan 4 (1975) 47; Allertonia 1 (1977) 201. — *Thelypteris* subg. *Sphaerostephanos* K. IWATS. Mem. Coll. Sci. Univ. Kyoto B, 31 (1964) 32.

*Mesochlaena* R. BR. in Benn. & Br. Pl. Jav. Rar. (1838) 5, *nom. illeg.*; J. SM. in Hook. J. Bot. 3 (1840) 18; C. CHR. Ind. Fil. (1905) xxii.

*Proferea* PRESL, Epim. Bot. (1851) 259; HOLTUM, Novit. Bot. Inst. Bot. Univ. Carol. Prag. 1968 (1969) 48.

*Cyclosorus sensu* CHING, Bull. Fan Mem. Inst. Biol. Bot. 8 (1938) 162, *p.p.*; *sensu* COPEL. Gen. Fil. (1947) 140, *p.p.*; *sensu* HOLTUM, Rev. Fl. Mal. 2 (1955) 255, *p.p.*

*Thelypteris* subg. *Glaphyopteridopsis* sect. *Neocyclosorus* K. IWATS. Mem. Coll. Sci. B, 31 (1964) 30, *quoad spec. typ.*

*Thelypteris* subg. *Pneumatopteris* sect. *Macrocyclusorus* K. IWATS. *l.c.* 34, *quoad spec. typ.* — **Fig. 1a–h, q, 12, 13.**

Caudex in most species erect or short-creeping, rarely long-creeping or scandent; scales usually narrow, thin, bearing superficial acicular hairs; much-reduced pinnae present at base of fronds, the transition downwards to these from normal pinnae usually abrupt but in some cases quite gradual (a few species are included which have no reduced basal pinnae but have deeply lobed normal pinnae with glands typical of this genus); aerophores at pinna-bases often swollen, in some species 1–2 mm long (very young fronds then covered with mucilage); apex of frond rarely pinna-like; pinnae in most species lobed (in some very deeply) or crenate, in a few subentire; sinus-membrane almost always distinct, of varying length; veins anastomosing, but in a few species just meeting at the sinus or ending above it; sessile spherical yellow glands usually present on parts of the surface of pinnae or on indusia or sporangia, in a minority of species quite lacking; short capitate hairs lacking; acicular hairs almost always present on both surfaces of costae and costules, lacking on the lower surface in a few species, often present also between veins on either or both surfaces, either erect or appressed, rarely if ever septate; lower surface rarely pustular when dry; sori usually round, in some species (indusiate or not) more or less elongate; indusia usually present; sporangia often bearing yellow



glands distally, less often setae, usually with a gland-tipped hair on the stalk; spores usually bearing many small wings, in some species a continuous wing with cross-wings.

Type species: *Sphaerostephanos asplenoides* J. SM. = *S. polycarpus* (BL.) COPEL.

Distr. Throughout *Malesia* (152 spp.), tropical mainland Asia (12 spp.), Mascarene Islands and E. Africa (4 spp.), Australia and the Pacific (17 spp., only 1 reaching Tahiti).

Ecol. Almost all are forest plants. Nearly all those adapted to open places have long-creeping rhizomes and are widely distributed; allied to one of these are a few species in New Guinea and the Solomons which have a slender scandent caudex, not known in any other genus of the family.

Cytol. Base chromosome number 36; 8 spp. examined, all diploid.

Taxon. JOHN SMITH's name *Sphaerostephanos* refers to the yellow glands which fringe the indusium of the type species. COPELAND and CHRISTENSEN treated this name as feminine, but as the Greek *stephanos* is masculine, I regard the compound name also as masculine. SMITH's original specimen had broken indusia (carefully illustrated by FRANCIS BAUER) from which he gained an erroneous idea of their structure. Soon afterwards SMITH received from ROBERT BROWN a better specimen, and his comments on it were published in 1840 under BROWN's name *Mesochlaena* which SMITH regarded as having priority; he then realized that it differed from *Nephrodium* (as interpreted by SCHOTT) only in having an elongate sorus. BROWN's name *Mesochlaena* had been published in 1838 with a very slight description and without any indication of its status, so that it cannot be regarded as a valid generic name, as pointed out by COPELAND in 1929. The first good illustration of the sorus was published by METTENIUS (Fil. Hort. Lips. t. 18, fig. 13. 1857) with the name *Mesochlaena javanica*; this was changed to *Nephrodium javanicum* by HOOKER who published an excellent illustration of a whole plant (Fil. Exot. t. 62. 1859), with *Aspidium polycarpon* BL. as a synonym and reference to SMITH's comments of 1840.

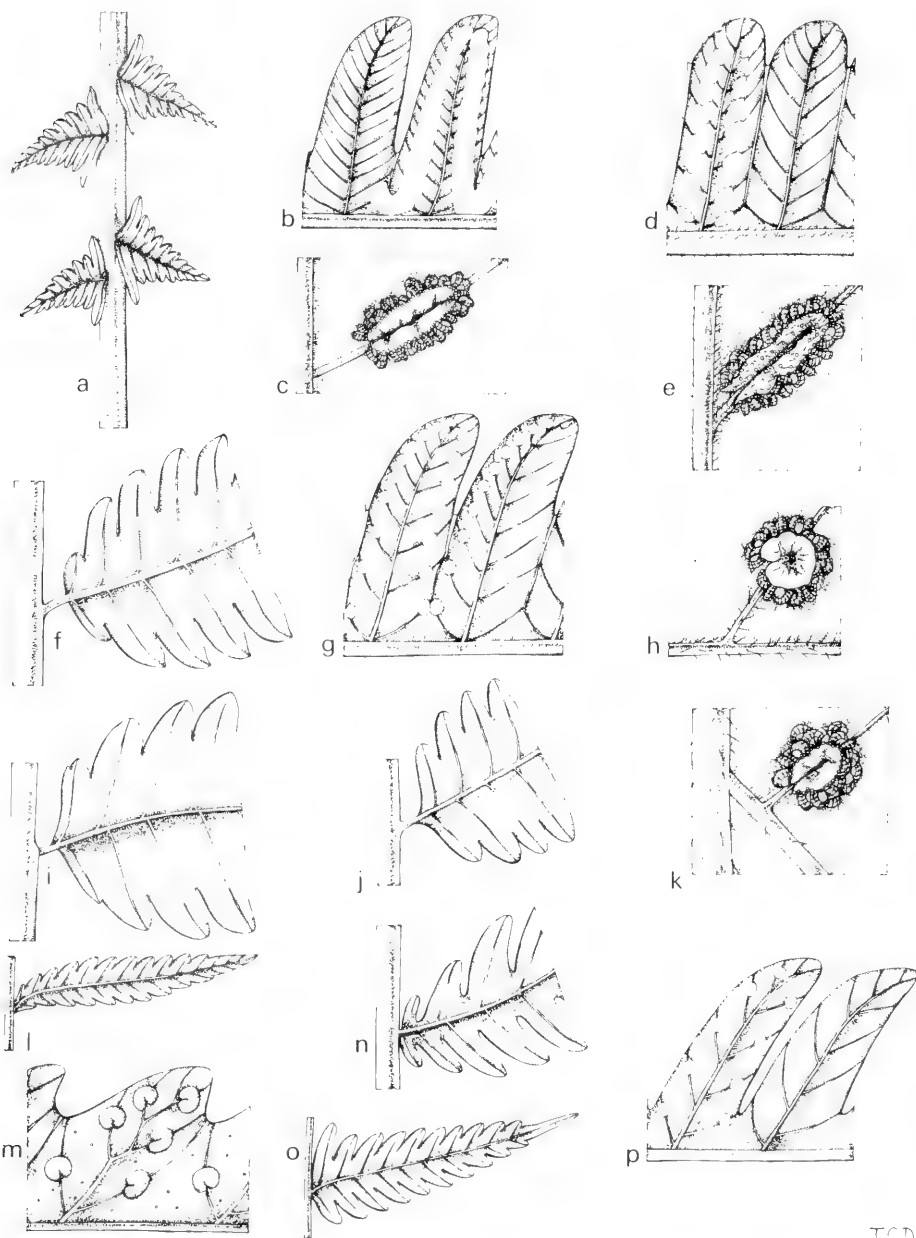
When BEDDOME published the Supplement to his Handbook (1892) he also reverted to the genus *Nephrodium* for *Aspidium polycarpon* BL., and described an additional Malayan species *N. larutense* which also has elongate sori. In Index Filicum (1905) CHRISTENSEN retained the generic name *Mesochlaena* for *M. polycarpa* but transferred BEDDOME's *N. larutense* to *Dryopteris*. VAN ALDERWERELT accepted the generic name *Mesochlaena* in his Handbook (1908), transferring *N. larutense* to it and later adding two more species. In the third Supplement to Index Filicum CHRISTENSEN followed COPELAND in adopting the name *Sphaerostephanos* and transferred to it v.A.v.R.'s names.

The species thus brought together in *Sphaerostephanos* are not a closely allied group, and there are others (e.g. *S. norrisii*) which have slightly elongate sori, so that no clear line can be drawn between species with elongate and those with round sori. For these reasons, in 1955 I transferred the Malayan species with elongate sori to *Cyclosorus*, a genus which I accepted in the sense of CHING (1938), though commenting on the unsatisfactory nature of generic delimitation in the family *Thelypteridaceae* at that time. CHING however had misinterpreted the sorus of the type species of *Sphaerostephanos* and had wrongly reported the spores as trilete, for which reasons he proposed for it a new family (*Sunyatsenia* 5, 1940, 240).

When I had made a preliminary study of all known species of *Thelypteridaceae* in preparation for the present work, I made a survey of all existing generic names and found that *Sphaerostephanos* was the oldest name for a large group of mainly Malesian species most of which do not have elongate sori. For this reason in 1971 I published a revised concept of the genus, which is here adopted. Species of this genus were variously placed in IWATSUKI's classification of 1964, which makes no reference to the majority of Malesian species; I cite above only infrageneric taxa which he typified by Malesian species.

The main characters of this genus are the presence of much-reduced basal pinnae and of sessile non-resinous spherical yellow glands of an easily recognized type; these glands are not destroyed in the process of drying specimens for the herbarium as those of *Coryphopteris* and *Amphineuron* often are. The species can be arranged in a series beginning with those that have glands on both surfaces of pinnae and on indusia and sporangia, then those lacking glands on the upper surface (there are no species bearing glands on the upper surface and not on the lower), those with glands only on sori and finally those with no glands at all. Species without glands agree with *Pneumatopteris* in having reduced basal pinnae but have a much greater complement of acicular hairs on all parts (especially on sporangia); they lack also short capitate hairs and the peculiar pustules on the lower surface of dried fronds which are characteristic of *Pneumatopteris*.

I also found that some species had very few reduced pinnae and that there is not a sharp distinction in this character between *Sphaerostephanos* and *Pronephrium*. This matter is discussed under *Pronephrium*; I believe that the great majority of species belong clearly to one genus or the other.



J.C.D.

Fig. 12. *Sphaerostephanos polycarpus* (BL.) COPEL. a. Reduced pinnae,  $\times \frac{2}{3}$ ; b. venation and position of sori,  $\times 3$ ; c. sorus,  $\times 12$ . — *S. larutensis* (BEDD.) C. CHR. d. Venation, sinus-membrane and sori,  $\times 3$ ; e. sorus,  $\times 12$ . — *S. norrisii* (ROSENST.) HOLTUM. f. Base of lower pinna,  $\times 1.5$ ; g. venation and sori,  $\times 3$ ; h. sorus,  $\times 12$ . — *S. pilososquamatus* (v.A.v.R.) HOLTUM. i. Base of sterile pinna,  $\times 1.5$ ; j. base of fertile pinna,  $\times 1.5$ ; k. sorus,  $\times 12$ . — *S. hispidifolius* (v.A.v.R.) HOLTUM. l. Middle pinna,  $\times 1$ ; m. venation and sori,  $\times 8$ . — *S. inconspicuus* (COPEL.) HOLTUM. n. Base of lower pinna,  $\times 2$ ; o. upper pinna,  $\times 1.5$ ; p. venation and sori,  $\times 4$  (a–b YAPP 215, c MATTHEW s.n., d–e ERNST s.n., f KUNSTLER 2360, g–h MATTHEW s.n., i–k cult. Kew, l–m G. F. HOSE 91, n–p P. S. SHIM SAN 81677).

As the sessile spherical yellow glands are the most distinctive feature of the genus, I regard the development of these on all parts of the frond as a primitive character. Assuming also that the original species had an erect caudex, *S. polycarpus* might be regarded as a prototype for the genus. It is one of the largest species vegetatively. But it is not a forest plant (a reason for its wide distribution) and it has deeply lobed pinnae, whereas the most widely distributed Malesian forest species with glands on both surfaces is *S. penniger*, which has shallowly lobed pinnae with several pairs of anastomosing veins; it is allied to the arborescent *S. arbuscula* (WILLD.) HOLTUM of Southern India and the Mascarene Islands. So I suggest that the primitive *Sphaerostephanos* had shallowly-lobed pinnae with anastomosing veins, and that *S. arbuscula* is the nearest surviving species. Several New Guinea species have a slender erect caudex and shallowly-lobed pinnae (e.g. *S. arfakianus*) but have no glands on the upper surface. At least it can be said with some certainty that (as in *Christella*) the few species which have free veins are probably not primitive but represent a secondary development occurring locally in a few areas (e.g. *S. inconspicuus* in Borneo, *S. novoguineensis* in New Guinea and *S. pycnosorus* in Samoa); they do not form a coherent natural group.

A few species have quite gradually reduced basal pinnae (e.g. *S. hastatopinnatus* and *S. arfakianus*, both with an erect caudex) but most have an abrupt (or almost abrupt) transition from normal to reduced pinnae at the base of the frond. A few species which have many reduced pinnae are somewhat intermediate, showing first a gradual reduction downwards and then an abrupt transition to much smaller pinnae (e.g. *S. hispiduliformis*). I suggest that the condition of gradual reduction is the more primitive arrangement, as it alone occurs in *Cyathea*. Apart from *Sphaerostephanos* and *Pneumatopteris*, which are predominantly Malesian in distribution and certainly allied, most other genera have basal pinnae gradually or not at all reduced.

The species with long-creeping rhizome are *S. unitus*, a gland-bearing species very widely distributed with distinct eastern and western varieties, and *S. invisus* which lacks glands and is mainly distributed in the Pacific (its distribution is similar to that of *Pneumatopteris costata*). *S. hirtisorus* (C. CHR.) HOLTUM in N.E. India and W. China appears to be related to *S. invisus*.

The following key is based on the distribution of glands on the surfaces of pinnae and on sori. I believe that this represents an evolutionary trend, but within it there are many separate bifurcations which, in such a complex group, are not easy to discern. For example, there is a group of species which are related to *S. stipellatus* and have closely appressed hairs on the lower surface of costae and costules; this character may be associated with elongate aerophores and lack of glands on the lower surface of pinnae (as in *S. stipellatus* itself) or with varying combinations of these and other characters. Varying trends may lead on to other groups (e.g. elongate aerophores may be associated with erect hairs on the lower surface of costae) and I cannot see how to follow all the trends or delimit sub-groups. It seems to me evident that the present condition of the genus is due to rapid and complex recent evolution, especially in New Guinea, resulting in a difficulty in the delimitation of species, with some necessary inequality of treatment. The destruction of Malesian forests may put a stop to this process or alter it in unpredictable ways.

In some species where glands are not abundant there seems to be some variation in their occurrence; in such cases a species may appear in more than one place in the key.

KEY TO THE SPECIES

- 1. Glands present between veins on upper surface of pinnae.
- 2. Six or more pairs of lower pinnae gradually reduced . . . . . 1. *S. debilis*
- 2. Transition to reduced basal pinnae (if any) abrupt or subabrupt.
- 3. Sori elongate.
- 4. No basal reduced pinnae . . . . . 2. *S. sudesticus*
- 4. Basal reduced pinnae present.
- 5. Middle pinnae sessile . . . . . 3. *S. polycarpus*
- 5. Middle pinnae with stalks 3–10 mm long . . . . . 4. *S. eminens*
- 3. Sori not elongate.
- 6. Sori exindusiate.
- 7. Basal veins quite free . . . . . 5. *S. williamsii*
- 7. Basal veins anastomosing.
- 8. Pinnae to 10 × 1.5 cm; reduced pinnae at least 5 pairs . . . . . 6. *S. stenodontus*
- 8. Pinnae to 21 × 2.5 cm; reduced pinnae 2–3 pairs . . . . . 7. *S. flavoviridis*
- 6. Sori indusiate.
- 9. Reduced pinnae c. 30 pairs . . . . . 8. *S. trimetralis*
- 9. Reduced pinnae rarely more than 12 pairs.
- 10. Lower surface of rachis and costae quite glabrous, or with very short hairs on costae only.

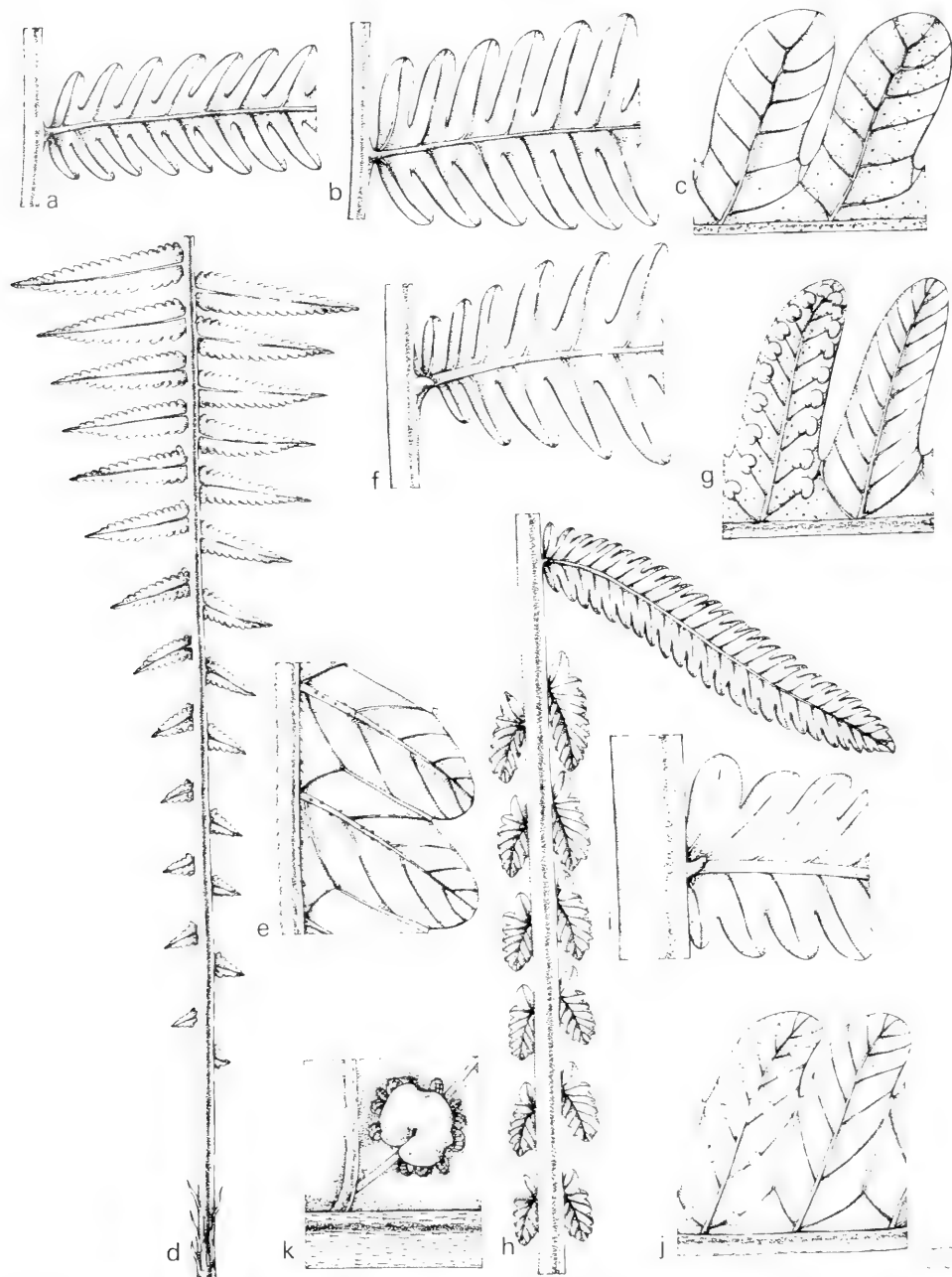


Fig. 13. *Sphaerostephanos alatellus* (CHRIST) HOLTUM. a. Base of fertile pinna,  $\times 1\frac{1}{2}$ ; b. base of sterile pinna,  $\times 1\frac{1}{2}$ ; c. fertile pinna-lobes,  $\times 4$ . — *S. archboldii* (C. CHR.) HOLTUM. d. Base of frond,  $\times 1$ ; e. pinna-lobes,  $\times 6$ . — *S. baramensis* (C. CHR.) HOLTUM. f. Base of pinna,  $\times 1\frac{1}{2}$ ; g. lobes of fertile pinna,  $\times 3$ . — *S. batacorum* (ROSENST.) HOLTUM. h. Base of frond,  $\times \frac{1}{2}$ ; i. base of pinna,  $\times 2$ ; j. lobes at middle of pinna,  $\times 4$ ; k. costa and costule, with appressed hairs, and sorus,  $\times 12$  (a–c PULLEN 8258, d–e BRASS 30856, f–g HOLTUM 1, h–k MATTHEW 946).

11. Fronds dimorphous; reduced pinnae all minute . . . . . 9. *S. alatellus*
11. Fronds not dimorphous; reduced pinnae conspicuous . . . . . 10. *S. daymanianus*
10. Hairs present throughout lower surface of rachis and costae.
12. Sporangia copiously setiferous, rarely also with a gland.
13. Pinnae c. 7 pairs, to  $13 \times 2.7$  cm . . . . . 31. *S. penniger*
13. Pinnae, if only 7 pairs, much smaller.
14. One pair of veins anastomosing, next pair to sinus-membrane . . . 11. *S. appendiculatus*
14.  $1\frac{1}{2}$ –2 pairs anastomosing,  $1\frac{1}{2}$  pairs to sinus-membrane . . . . . 12. *S. pseudomegaphyllus*
12. Sporangia usually bearing glands, sometimes with 1–2 setae.
15. Reduced pinnae 0–3 pairs.
16. Pinnae not more than 10 pairs, reduced ones usually lacking . . . . 13. *S. diversilobus*
16. Pinnae at least 20 pairs, reduced ones always present.
17. Pinnae lobed not more than half-way to costa . . . . . 14. *S. dichotrichus*
17. Pinnae lobed fully  $\frac{3}{4}$  . . . . . 15. *S. vestigiatus*
15. Reduced pinnae on well-grown plants at least 5 pairs.
18. Pinnae not more than 4 cm wide, their lobes not acute.
19. Pinnae crenate to subentire.
20. Pinnae subentire; sinus-membrane hardly detectable . . . . . 16. *S. morotaiensis*
20. Pinnae crenate, at least distally; sinus-membrane evident.
21. Pinnae to  $3.5 \times 1.0$  cm; reduced pinnae all very small . . . . . 17. *S. kalkmanii*
21. Pinnae (at least sterile ones) to 7 cm or more long, upper reduced pinnae at least 7 mm long.
22. Pinnae to 12–15 cm long; sinus-membrane distally widened and translucent.
23. Bases of pinnae cuneate, not auricled nor dilated; costules at  $45^\circ$  to costa . . . . . 18. *S. perglanduliferus*
23. Bases of pinnae truncate, lower ones auricled and dilated; costules at c.  $60^\circ$  to costa . . . . . 19. *S. veitchii*
22. Pinnae to 8 cm long; sinus-membrane distally not widened nor translucent . . . . . 20. *S. lamii*
19. Pinnae lobed at least  $\frac{3}{4}$  towards costa.
24. Aerophores elongate . . . . . 21. *S. hirsutus*
24. Aerophores not elongate.
25. Bases of pinnae, at least lower ones, dilated both sides.
26. Hairs on lower surface of rachis and costae erect, to 1 mm long on sterile fronds . . . . . 22. *S. acrostichoides*
26. Hairs on lower surface of rachis and costae shorter, antrorse or appressed . . . . . 23. *S. melanorachis*
25. Bases of pinnae not dilated.
27. Only 1 pair of veins truly anastomosing, second acroscopic vein sometimes touching sinus-membrane.
28. Basal pinnae much narrowed at their bases . . . . . 24. *S. heterocarpus*
28. Basal pinnae not or little narrowed at their bases.
29. Reduced pinnae all very small . . . . . 25. *S. isomorphus*
29. Reduced pinnae to 1.5 cm or more long.
30. Hairs on lower surface of rachis and costae less than 0.1 mm long; no setae on sporangia . . . . . 26. *S. dimidiolobatus*
30. Hairs on lower surface of rachis and costae 0.2 mm or more long; sporangia setiferous . . . . . 30. *S. productus*
27. At least  $1\frac{1}{2}$  pairs of veins truly anastomosing and 1 vein touching sinus-membrane.
31. Pinnae lobed  $\frac{3}{4}$  towards costa, lower ones auricled on acroscopic base . . . . . 27. *S. solutus*
31. Pinnae lobed not over  $\frac{3}{4}$ , lower ones not auricled.
32. Pinnae lobed fully  $\frac{1}{2}$ , widest in distal half . . . . . 28. *S. hernaезii*
32. Pinnae in most cases lobed less than  $\frac{1}{2}$ , not widened distally.
33. Fertile pinnae little more than 2 cm wide;  $1\frac{1}{2}$ – $2\frac{1}{2}$  pairs of veins truly anastomosing.
34. Reduced pinnae 3–5 pairs, all very small . . . . . 29. *S. moseleyi*
34. Reduced pinnae commonly 8 pairs or more, upper ones at least  $1 \times 1$  cm, rounded . . . . . 30. *S. productus*
33. Fertile pinnae commonly 2.5–3.0 cm wide;  $3$ – $3\frac{1}{2}$  pairs of veins truly anastomosing . . . . . 31. *S. penniger*
18. Pinnae to 7 cm wide, deeply lobed, lobes narrowly acute . . . . . 31. *S. penniger*
1. Glands lacking or rare on upper surface of pinnae.
35. Glands present on lower surface of pinnae between veins.

36. Pinnae 2–4 cm long, 3–4 mm wide, subentire, several lower pairs gradually reduced . . . . . 32. *S. warburgii*
36. Pinnae, if subentire, much wider; transition to reduced basal pinnae ± abrupt.
37. Sporangia bearing several setae, sometimes also a gland.
38. Normal pinnae 3–4 pairs, 11 × 4 cm or larger; reduced pinnae 12–15 pairs . . . . . 33. *S. tandikatensis*
38. Normal pinnae more numerous or smaller.
39. Pinnae opposite, 6–7 pairs, 10 × 2.7 cm or larger . . . . . 34. *S. carrii*
39. Not this combination of characters.
40. Sori exindusiate.
41. Pinnae c. 12 × 1.5 cm, lobed over  $\frac{1}{2}$ ; reduced pinnae 15 pairs . . . . . 35. *S. exindusiatus*
41. Pinnae c. 6 × 1.8 cm, lobed less than  $\frac{1}{2}$ ; reduced pinnae 2 pairs . . . . . 36. *S. lucbanii*
40. Sori indusiate.
42. Reduced pinnae 1–2 pairs, normal pinnae 2–4 pairs 3.5 cm long . . . . . 37. *S. major*
42. Not this combination of characters.
43. Reduced pinnae at least 6 pairs; transition to large pinnae abrupt.
44. Reduced pinnae 25–30 pairs . . . . . 38. *S. polyotis*
44. Reduced pinnae rarely more than 12 pairs.
45. Pinnae lobed conspicuously more than  $\frac{1}{2}$  way to costa.
46. Pinnae c. 12 pairs, 12.5 × 2.4 cm . . . . . 39. *S. grandescens*
46. Pinnae 25–30 pairs, proportionately narrower.
47. Pinnae to 21 × 2.5 cm . . . . . 40. *S. magnus*
47. Pinnae to 16 × 1.5 cm . . . . . 41. *S. santomasii*
45. Pinnae lobed about  $\frac{1}{2}$  or little more deeply.
48. Reduced pinnae all small, to 3 mm long . . . . . 42. *S. trichochlamys*
48. Reduced pinnae all conspicuous . . . . . 11. *S. appendiculatus*
43. Reduced pinnae not more than 4 pairs, transition not abrupt.
49. Texture rigid; pinna-lobes dentate at vein-ends . . . . . 43. *S. adenostegius*
49. Texture thin; pinna-lobes entire . . . . . 14. *S. dichrotrichus*
37. Sporangia in most cases bearing glands, sometimes a seta with the glands.
50. Pinnae subentire, very narrowly cuneate at basiscopic base . . . . . 44. *S. aquatilis*
50. Pinnae otherwise.
51. Reduced pinnae 0–2 (–3) pairs, small, irregularly spaced.
52. Basal veins free . . . . . 45. *S. hispidifolius*
52. Basal veins anastomosing.
53. 1 or 2 pairs of pinnae 6–8 cm long and 1 pair very small . . . . . 46. *S. uniauriculatus*
53. Normal pinnae several pairs.
54. Upper surface of pinnae bearing appressed hairs between veins.
55. Free pinnae 3–4 pairs below long apical lamina . . . . . 47. *S. urdanetensis*
55. Free pinnae more numerous; apical lamina not elongate.
56. Sterile pinnae not more than 3.5 × 1.2 cm.
57. Hairs on lower surfaces all short and mostly appressed.
58. Pinnae 12–15 pairs, 3.5 cm long, symmetrically many-lobed . . . . . 48. *S. batjanensis*
58. Pinnae 5 pairs, c. 16 cm long, with few irregular lobes . . . . . 49. *S. humilis*
57. Hairs on lower surface of rachis and costae erect, to 1 mm long . . . . . 50. *S. lastreoides*
56. Sterile pinnae to 8 × 1.8 cm . . . . . 50. *S. lastreoides*
54. Upper surface of pinnae lacking appressed hairs between veins.
59. Pinnae 7–10 × 1 cm . . . . . 51. *S. cataractorum*
59. Pinnae not over 5.5 cm long, more than 1 cm wide.
60. Pinnae not dimorphous; apical lamina narrow, 10 cm long . . . . . 52. *S. menadensis*
60. Pinnae dimorphous; apical lamina broadly triangular, shorter . . . . . 53. *S. subcordatus*
51. Reduced pinnae at least 4 pairs, regularly spaced; transition to normal pinnae gradual or abrupt.
61. Aerophores distinctly elongate.
62. Basal veins quite free, not meeting at sinus . . . . . 54. *S. novoguineensis*
62. Basal veins meeting at sinus, or anastomosing below it.
63. Pinnae entire or slightly crenate.
64. Pinnae c. 5 × 1 cm, distinctly crenate; transition to 15 pairs of reduced pinnae subabrupt . . . . . 55. *S. hispiduliformis*
64. Pinnae larger, almost entire; 12 pairs of lower pinnae gradually reduced . . . . . 56. *S. hastatopinnatus*
63. Pinnae distinctly lobed.

65. Appressed hairs present between veins on upper surface of pinnae.  
 66. 12 pairs of lower pinnae gradually reduced and 20 pairs of smaller ones . . . . . 55. *S. hispiduliformis*
66. Subabrupt transition to reduced lower pinnae.  
 67. Pinnae lobed not or little more than  $\frac{1}{2}$  way to costa.  
 68. Reduced pinnae conspicuous, upper ones 1–3 cm long.  
 69. Pinnae  $12 \times 1.6$  to  $20 \times 2$  cm, gradually acuminate; lower surface of costae glabrous or with sparse short hairs . . . . . 57. *S. latebrosus*  
 69. Pinnae to  $14 \times 2.5$  cm, abruptly short-acuminate; lower surface of costae densely covered with appressed hairs . . . . . 58. *S. porphyricola*
68. Reduced pinnae all very small.  
 70. Lower surface of rachis and costae almost glabrous . . . . . 59. *S. caulescens*  
 70. Lower surface of rachis and costae bearing hairs to 1 mm long.  
 71. Largest pinnae commonly 15–20 cm long; hairs on rachis pale . . . . . 21. *S. hirsutus*  
 71. Largest pinnae  $7 \times 1.5$  cm; hairs on rachis brown . . . . . 60. *S. reconditus*
67. Pinnae lobed conspicuously more than  $\frac{1}{2}$  way to costa.  
 72. Hairs on lower surface of costules antroresely appressed.  
 73. Sori supramedial; pinnae to 2.5 cm wide.  
 74. Basal normal pinnae not narrowed at base . . . . . 61. *S. cyrtocaulos*  
 74. Several pairs of lower pinnae much narrowed at their bases . . . . . 62. *S. baramensis*  
 73. Sori inframedial; pinnae to 1.5 cm wide . . . . . 63. *S. batulantis*
72. Hairs on lower surface of costules not antrorese.  
 75. Reduced pinnae all conspicuous, lowest 5 mm long . . . . . 64. *S. subalpinus*  
 75. Reduced pinnae all small, uppermost 5 mm long.  
 76. Dark hairs on both sides of rachis . . . . . 65. *S. lobatus*  
 76. Pallid hairs on both sides of rachis.  
 77. Lowest pinnae little narrowed at base; reduced pinnae evident . . . . . 66. *S. ellipticus*  
 77. Lower pinnae much narrowed at base; all reduced pinnae minute . . . . . 67. *S. foxworthyi*
65. No appressed hairs on upper surface between veins.  
 78. Hairs on lower surface of costules copious, closely appressed.  
 79. Reduced pinnae all very small, basal normal pinnae narrowed at base.  
 80. Pinnae lobed less than  $\frac{1}{2}$  towards costa . . . . . 68. *S. indrapurae*  
 80. Pinnae lobed about  $\frac{1}{2}$  . . . . . 62. *S. baramensis*  
 79. Reduced pinnae conspicuous, many 10–15 mm long; basal normal pinnae not narrowed at base . . . . . 69. *S. batacorum*
78. Hairs on lower surface of costules short, not appressed.  
 81. Sori indusiate; sporangia glandular, rarely with a seta.  
 82. Lowest normal pinnae narrowed at base . . . . . 70. *S. angustibasis*  
 82. Lowest normal pinnae not narrowed at base . . . . . 57. *S. latebrosus*  
 81. Sori exindusiate; neither glands nor setae on sporangia.  
 83. Pinnae thin, lobed to 2 mm from costa . . . . . 71. *S. nudisorus*  
 83. Pinnae subcoriaceous, lobed little more than  $\frac{1}{2}$  . . . . . 72. *S. paripinnatus*
61. Aerophores not or slightly elongate.  
 84. Basal veins both passing to sides of sinus-membrane or uniting just below it, not or rarely forming a distinct excurrent vein.  
 85. Reduced pinnae all with distinct lamina; costules 2.5 mm apart . . . . . 73. *S. novae-britanniae*  
 85. Reduced pinnae without distinct lamina; costules 4 mm apart . . . . . 74. *S. convergens*
84. Basal veins uniting to form an excurrent vein, at least near base of pinna.  
 86. Sori supramedial; caudex a long-creeping rhizome . . . . . 75. *S. unitus*  
 86. Sori medial or inframedial; caudex not long-creeping.  
 87. Pinnae to 2.5 cm long; dark hairs on upper surface of rachis . . . . . 76. *S. sessilipinna*  
 87. Not this combination of characters.  
 88. Lower surface of rachis glabrous or nearly so; hairs on lower surface of base of costae none or very short.  
 89. Reduced pinnae all very small.  
 90. Largest pinnae c. 6 cm long . . . . . 77. *S. lobangensis*  
 90. Largest pinnae at least 10 cm long.  
 91. Fertile pinnae to  $16 \times 2$  cm, lobed at most  $\frac{5}{8}$  . . . . . 78. *S. gymnorachis*  
 91. Fertile pinnae to  $26 \times 3$  cm, lobed  $\frac{3}{4}$  . . . . . 79. *S. pullenii*
89. Reduced pinnae: upper ones 1.5–2 cm long, lower gradually smaller.  
 92. Pinnae lobed to a depth of 2 mm . . . . . 80. *S. gregarius*

92. Pinnae lobed at least  $\frac{1}{2}$  way to costa . . . . . 57. *S. latebrosus*
88. Lower surface of rachis and costae hairy throughout.
93. Pinnae crenate.
94. Pinnae not more than  $4.5 \times 1.4$  cm; veins 4–5 pairs, 1– $1\frac{1}{2}$  pairs anastomosing.
95. Pinnae 5–6 pairs . . . . . 81. *S. tephrophyllus*
95. Pinnae 18 pairs . . . . . 17. *S. kalkmanii*
94. Sterile pinnae to  $8 \times 1.7$  cm;  $2\frac{1}{2}$  pairs of veins anastomosing; sinus-membrane very short  
20. *S. lamii*
93. Pinnae distinctly lobed.
96. Fronds dimorphous; sterile pinnae to  $25 \times 3.5$  cm . . . . . 82. *S. pilososquamatus*
96. Fronds not or little dimorphous, pinnae not over 2.5 cm wide.
97. Pinnae to  $9.5 \times 0.8$ – $0.9$  cm . . . . . 83. *S. angustifolius*
97. Pinnae proportionately wider, to at least 1.5 cm wide.
98. Lowest normal pinnae much narrowed at base . . . . . 24. *S. heterocarpus*
98. Lowest normal pinnae not narrowed at base.
99. Hairs 1 mm long on lower surface of rachis and costae; indusia with long hairs.
100. Pinnae lobed less than  $1/2$  way to costa . . . . . 84. *S. efogensis*
100. Pinnae lobed more than  $1/2$  way to costa.
101. Reduced pinnae c. 5 pairs . . . . . 85. *S. dichrotrichoides*
101. Reduced pinnae many pairs . . . . . 3. *S. polycarpus*
99. Hairs in most cases less than 0.5 mm long on lower surface of rachis and costae; glands present on indusia.
102. Lowest veins sometimes both touching sides of sinus-membrane; pinnae lobed  $2/3$ – $3/4$  . . . . . 86. *S. nakaikai*
102. Lowest veins always anastomosing; pinnae lobed c.  $3/5$ .
103. Pinnae rigid, lobes of larger ones toothed distally; reduced pinnae not over 8 pairs.
104. Reduced pinnae 4–5 pairs; upper surface of pinnae bearing appressed hairs between veins . . . . . 87. *S. woitapensis*
104. Reduced pinnae 8 pairs; upper surface of pinnae lacking appressed hairs  
88. *S. ekutiensis*
103. Pinnae thin, lobes not toothed; reduced pinnae 12–15 pairs.
105. Hairs on lower surface of costae not appressed.
106. Hairs on lower surface of costae all very short . . . . . 57. *S. latebrosus*
106. Some hairs 0.5 mm or more long on lower surface of costae . . . . . 66. *S. ellipticus*
105. Lower surface of costae covered with closely appressed hairs  
58. *S. porphyricola*
35. Glands between veins on lower surface of pinnae lacking.
107. Glands present on lower surface of costules and veins.
108. Pinnae 3–4 pairs, to  $1.1 \times 0.5$  cm, basal pinnae somewhat reduced . . . . . 89. *S. omatianus*
108. Pinnae more numerous or larger, or several pairs reduced basal pinnae.
109. All pinnae with narrowly cuneate basiscopic base . . . . . 44. *S. aquatilis*
109. Pinnae symmetrically broadly cuneate or truncate at base.
110. Few to many pairs of lower pinnae gradually reduced.
111. Pinnae subentire to crenate.
112. Pinnae to  $3.5 \times 1.0$  cm; pinna-lobes with strongly reflexed edges.
113. Sporangia setiferous; 12–14 pairs of lower pinnae gradually reduced . . . . . 90. *S. alticola*
113. Sporangia not setiferous; 4–5 pairs of lower pinnae gradually reduced . . . . . 91. *S. rigidus*
112. Pinnae larger, edges of lobes not strongly reflexed.
114. Sori exindusiate; lower surface of costae and costules glabrous  
56. *S. hastatopinnatus*
114. Sori indusiate; short hairs abundant on lower surface of rachis and costae  
92. *S. arfakianus*
111. Pinnae lobed  $\frac{1}{3}$ – $\frac{2}{3}$  towards costa.
115. 1–4 pairs of basal pinnae gradually reduced . . . . . 43. *S. adenostegius*
115. Many pairs of basal reduced pinnae.
116. 7–12 pairs of lower pinnae gradually reduced with subabrupt change to 12 pairs much smaller . . . . . 55. *S. hispiduliformis*
116. Similar transition but 2–6 pairs of small basal pinnae . . . . . 93. *S. archboldii*
110. Transition to reduced basal pinnae (if any) abrupt or nearly so.



117. Reduced pinnae 0-3 pairs.
118. Pinna-lobes strongly concave beneath . . . . . 91. *S. rigidus*
118. Pinnae-lobes not concave beneath.
119. Pinnae widened distally . . . . . 13. *S. diversilobus*
119. Pinnae not widened distally.
120. Caudex short-creeping; pinnae lobed c.  $\frac{2}{5}$  towards costa.
121. Fronds not dimorphous; sori supramedial.
122. Pinnae  $3.5 \times 1.4$  cm, narrowed evenly to apex . . . . . 94. *S. tibangensis*
122. Pinnae larger, abruptly short-acuminate . . . . . 95. *S. norrisii*
121. Fronds dimorphous; sori medial . . . . . 82. *S. pilos squamatus*
120. Caudex slender, erect; pinnae crenate . . . . . 96. *S. semimetralis*
117. Reduced pinnae at least 4 pairs.
123. Aerophores elongate.
124. Pinnae crenate.
125. Hairs on lower surface of costae minute . . . . . 97. *S. semicordatus*
125. Hairs on lower surface of costae appressed . . . . . 98. *S. pterosporus*
124. Pinnae lobed at least  $\frac{2}{5}$  towards costa.
126. Hairs on lower surface of costules appressed . . . . . 98. *S. pterosporus*
126. Hairs on lower surface of costules not appressed.
127. Reduced pinnae 20-30 pairs; normal pinnae lobed less than  $\frac{1}{2}$  way to costa.
128. Reduced pinnae acuminate . . . . . 99. *S. sagittifolius*
128. Reduced pinnae with rounded tips . . . . . 100. *S. foliolosus*
127. Reduced pinnae not more than 12 pairs; normal pinnae lobed  $\frac{1}{2}$  way to costa or more deeply.
129. Pinnae lobed  $\frac{3}{4}$  to costa.
130. Basal veins anastomosing; upper reduced pinnae 12 mm long . . . . . 101. *S. alpinus*
130. Basal veins free; upper reduced pinnae 3 mm long . . . . . 54. *S. novoguineensis*
129. Pinnae lobed about  $\frac{1}{2}$  to costa.
131. Pinnae c.  $6.5 \times 1.3$  cm, lowest narrowed at base; indusia glabrous . . . . . 102. *S. polisianus*
131. Pinnae c.  $11 \times 2$  cm, lowest not narrowed at base; indusia bearing long hairs . . . . . 103. *S. hoalensis*
123. Aerophores not elongate.
132. Sori elongate . . . . . 104. *S. larutensis*
132. Sori not or little elongate.
133. Reduced pinnae c. 30 pairs, deflexed, overlapping.
134. Reduced pinnae acuminate; normal pinnae 20 cm long . . . . . 99. *S. sagittifolius*
134. Reduced pinnae with rounded tips; normal pinnae smaller . . . . . 38. *S. polyotis*
133. Reduced pinnae not over 12 pairs, not overlapping.
135. Sori supramedial.
136. Pinnae lobed  $\frac{3}{4}$ , sporangia setiferous . . . . . 105. *S. loherianus*
136. Pinnae lobed less than  $\frac{1}{2}$ ; sporangia glandular . . . . . 75. *S. unitus*
135. Sori not supramedial.
137. Pinnae lobed more than  $\frac{1}{2}$ .
138. Sori indusiate; sporangia with glands.
139. Largest reduced pinna 7 mm long; hairs on lower surface of costae not appressed . . . . . 106. *S. erectus*
139. Largest reduced pinna 2 mm long; hairs on lower surface of costae appressed . . . . . 98. *S. pterosporus*
138. Sori exindusiate; sporangia setiferous . . . . . 107. *S. stresemannii*
137. Pinnae crenate or lobed less than  $\frac{1}{2}$ .
140. Pinnae not over 1 cm wide; indusia very small or lacking . . . . . 17. *S. kalkmanii*
140. Pinnae more than 1 cm wide; indusia all distinct.
141. Some hairs on lower surface of rachis and costae 1 mm or more long.
142. Pinnae commonly more than 2 cm wide, crenate to a depth of 1 mm.
143. Apex of frond pinna-like, crenate to base . . . . . 108. *S. simplicifolius*
143. Apex of frond deeply lobed at base . . . . . 109. *S. spenceri*
142. Pinnae to 1.7 cm wide, distinctly lobed . . . . . 84. *S. efogensis*
141. Hairs on lower surface of rachis and costae all very short.
144. Largest reduced pinnae 2 mm long . . . . . 98. *S. pterosporus*
144. Largest reduced pinnae at least 7 mm long.

145. Sporangia not setiferous.  
 146. Pinnae opposite; caudex 40 cm tall . . . . . 110. *S. mengienianus*  
 146. Pinnae not opposite; caudex suberect . . . . . 80. *S. gregarius*  
 145. Sporangia setiferous . . . . . 111. *S. confertus*
107. Glands lacking on lower surface of costules and veins.  
 147. Reduced pinnae c. 30 pairs.  
 148. Reduced pinnae acuminate . . . . . 99. *S. sagittifolius*  
 148. Reduced pinnae with rounded tips . . . . . 38. *S. polyotis*
147. Reduced pinnae much fewer.  
 149. Sporangia bearing glands (sometimes a seta also).  
 150. Hairs on lower surface of costules appressed.  
 151. Aerophores elongate.  
 152. Several pairs of lower pinnae gradually reduced . . . . . 112. *S. multiauriculatus*  
 152. Transition to reduced pinnae  $\pm$  abrupt.  
 153. Upper reduced pinnae 12 mm, lowest 6 mm long . . . . . 113. *S. stipellatus*  
 153. All reduced pinnae very short.  
 154. Pinnae lobed less than  $\frac{1}{2}$  . . . . . 98. *S. pterosporus*  
 154. Pinnae lobed more than  $\frac{1}{2}$ .  
 155. Indusia large, firm . . . . . 114. *S. plurifolius*  
 155. Indusia small, thin.  
 156. Basal veins anastomosing, second acroscopic vein to sinus-membrane  
 . . . . . 115. *S. hendersonii*  
 156. Basal veins often connivent at sinus-membrane, next veins both to margin  
 . . . . . 116. *S. posthumii*
151. Aerophores not elongate.  
 157. Basal acroscopic vein ending beside sinus-membrane, basiscopic vein at margin above base of sinus.  
 158. Pinnae 15–20 pairs; reduced pinnae 4–7 pairs . . . . . 117. *S. inconspicuus*  
 158. Pinnae to 30 pairs; reduced pinnae 2–3 pairs . . . . . 118. *S. subulifolius*
157. Basal veins both touching sinus-membrane or uniting below it.  
 159. Gradual transition to reduced pinnae at base of frond.  
 160. Indusia present . . . . . 92. *S. arfakianus*  
 160. Indusia absent . . . . . 112. *S. multiauriculatus*  
 159. Abrupt transition to very small reduced pinnae . . . . . 98. *S. pterosporus*
150. Hairs on lower surface of costules not appressed.  
 161. Basal veins not connivent below sinus.  
 162. Pinnae deeply lobed.  
 163. Pinnae to  $3.6 \times 1.0$  cm; veins 3–4 pairs . . . . . 119. *S. mjobergii*  
 163. Pinnae to  $10 \times 1.5$  cm; veins 9–10 pairs . . . . . 54. *S. novoguineensis*  
 162. Pinnae almost entire . . . . . 120. *S. mutabilis*
161. Basal veins connivent below sinus or uniting to form an excurrent vein.  
 164. Pinnae to  $4.2 \times 1.1$  cm; sori elongate with small indusia . . . . . 121. *S. uaniensis*  
 164. Pinnae in most cases much larger; sori otherwise.  
 165. Ten or more pairs of basal pinnae gradually reduced.  
 166. Pinna-margins sinuous or slightly crenate . . . . . 56. *S. hastatopinnatus*  
 166. Pinnae deeply lobed . . . . . 122. *S. echinosporus*
165. Abrupt transition to reduced pinnae if present.  
 167. Reduced pinnae 0–4 pairs on mature plants.  
 168. Pinnae almost entire, 3.5 cm or more wide . . . . . 123. *S. peltochlamys*  
 168. Pinnae distinctly lobed, narrower.  
 169. Pinnae lobed more than  $\frac{1}{2}$  . . . . . 124. *S. irayensis*  
 169. Pinnae lobed less than  $\frac{1}{2}$  . . . . . 95. *S. norrisii*
167. Reduced pinnae at least 6 pairs on mature plants.  
 170. Sori supramedial.  
 171. Caudex a long-creeping rhizome . . . . . 75. *S. unitus*  
 171. Caudex short, erect . . . . . 125. *S. lithophyllus*
170. Sori medial or inframedial.  
 172. Pinnae crenate . . . . . 109. *S. spenceri*  
 172. Pinnae lobed at least  $\frac{2}{3}$ .  
 173. Pinnae lobed more than  $\frac{1}{2}$  . . . . . 126. *S. hamiferus*

173. Pinnae lobed less than  $\frac{1}{2}$  . . . . . 80. *S. gregarius*
149. Sporangia lacking glands, in most cases bearing setae.
174. Aerophores elongate.
175. Pinnae entire or slightly crenate; veins 18–20 pairs . . . . . 127. *S. plurivenosus*
175. Pinnae distinctly lobed; veins rarely more than 12 pairs.
176. Pinnae lobed less than  $\frac{1}{2}$ .
177. Hairs on lower surface of costae and costules appressed.
178. Lower 12–15 pairs of pinnae gradually reduced, lowest 1 cm long . . . . . 112. *S. multiauriculatus*
178. Transition to small pinnae at base of frond abrupt . . . . . 128. *S. squamatellus*
177. Hairs on lower surface of costae and costules not appressed.
179. Reduced pinnae more than 12 pairs; sporangia not setiferous . . . . . 55. *S. hispiduliformis*
179. Reduced pinnae to 5 pairs; sporangia setiferous . . . . . 129. *S. canescens*
176. Pinnae lobed more than  $\frac{1}{2}$ .
180. Sporangia always with several setae.
181. Basal 2–3 pairs of pinnae somewhat narrowed at their bases.
182. Pinnae to  $11 \times 2.1$  cm, lobed  $\frac{3}{4}$ – $\frac{2}{3}$ ; hairs on lower surface of costules antrorse . . . . . 130. *S. suboppositus*
182. Pinnae to  $17 \times 2.8$  cm, lobed more than  $\frac{3}{4}$ ; hairs on lower surface of costules erect . . . . . 131. *S. makassaricus*
181. All pinnae in lower half of frond narrowed at their bases, lowest much narrowed . . . . . 132. *S. sarasinorum*
180. Sporangia rarely with a seta.
183. Pinnae lobed  $\frac{1}{4}$  or more deeply; reduced pinnae all very small.
184. Lower surface of rachis glabrous . . . . . 62. *S. baramensis*
184. Lower surface of rachis densely covered with erect brown hairs . . . . . 133. *S. muluensis*
183. Pinnae lobed at most  $\frac{3}{4}$ ; reduced pinnae 1–1.5 cm long . . . . . 126. *S. hamiferus*
174. Aerophores not elongate.
185. Sporangia not setiferous.
186. Pinnae not or little more than 5 cm long.
187. Pinnae crenate; sori inframedial.
188. Pinnae 10–20 pairs; 2–3 pairs of lower ones gradually reduced.
189. Caudex slender, erect; pinnae slightly crenate distally . . . . . 134. *S. telefominicus*
189. Caudex very short; pinnae crenate throughout . . . . . 135. *S. roemerianus*
188. Pinnae to 30 pairs; abrupt change to reduced ones at base . . . . . 136. *S. hellwigensis*
187. Pinnae lobed more than  $\frac{1}{2}$ ; sori supramedial . . . . . 137. *S. benoitianus*
186. Pinnae more than 10 cm long.
190. No reduced pinnae; normal pinnae distinctly stalked . . . . . 138. *S. neotoppingii*
190. At least 5 pairs lower pinnae gradually or abruptly reduced; all pinnae sessile.
191. Sori elongate and indusiate.
192. Normal pinnae not or little more than 2 cm wide; upper reduced pinnae 4 mm long . . . . . 139. *S. oosorus*
192. Normal pinnae commonly 2.5–3.5 cm wide; reduced pinnae much larger . . . . . 104. *S. larutensis*
191. Sori not elongate, or if so exindusiate.
193. Abrupt transition to 6 pairs of very small basal pinnae . . . . . 140. *S. rudis*
193. Basal pinnae not very small.
194. Rachis quite glabrous on lower surface; pinnae almost entire . . . . . 141. *S. dimorphus*
194. Rachis hairy on lower surface; pinnae crenate or lobed throughout . . . . . 142. *S. potamios*
185. Sporangia setiferous.
195. Caudex terrestrial and long-creeping, or scandent.
196. Caudex terrestrial; indusia distinct . . . . . 143. *S. invisus*
196. Caudex scandent; indusia very small or lacking.
197. Several pairs of lower pinnae gradually smaller and auricled on acroscopic base . . . . . 144. *S. austerus*
197. Transition to basal reduced pinnae abrupt . . . . . 145. *S. mundus*
195. Caudex various, not long-creeping nor scandent.
198. Lower 1–5 pairs of pinnae gradually reduced.
199. Pinnae to 2 cm long; no indusia . . . . . 146. *S. obtusifolius*
199. Pinnae to at least 4 cm long; indusia present . . . . . 43. *S. adenostegius*

198. At least 3 pairs of reduced pinnae distinct from normal ones.  
 200. Pinnae lobed  $\frac{1}{2}$  way to costa or more deeply.  
 201. Reduced pinnae 20 pairs, all very small . . . . . 147. *S. alcaidii*  
 201. Reduced pinnae to 12 pairs, all conspicuous.  
 202. Caudex short, erect; pinnae lobed  $\frac{1}{2}$  . . . . . 148. *S. pilosissimus*  
 202. Caudex tall, slender, if free-standing; pinnae lobed  $\frac{2}{3}$ – $\frac{3}{4}$  . . . . . 145. *S. mundus*  
 200. Pinnae lobed less than  $\frac{1}{2}$  way to costa.  
 203. Pinnae to 3.5 cm long, slightly crenate . . . . . 149. *S. erwinii*  
 203. Pinnae in most cases larger, deeply crenate or lobed.  
 204. Stipe 40–50 cm long; reduced pinnae 3 pairs, small . . . . . 82. *S. pilososquamatus*  
 204. Stipe much shorter; reduced pinnae more numerous, conspicuous.  
 205. Pinnae crenate; no long hairs on lower surface of rachis and costae.  
 206. Caudex erect; largest fertile pinnae  $17 \times 2.5$  cm . . . . . 150. *S. atasripii*  
 206. Caudex short-creeping; largest pinnae  $8 \times 2$  cm . . . . . 111. *S. confertus*  
 205. Pinnae distinctly lobed; long hairs usually present on lower surface of rachis and costae.  
 207. Stipe-scales 1 mm long; pinnae to  $4 \times 1$  cm . . . . . 151. *S. albosetosus*  
 207. Stipe-scales 7 mm long; pinnae to  $12 \times 2$  cm . . . . . 152. *S. wauensis*

**1. *Sphaerostephanos debilis* (METT.) HOLTUM, comb. nov.** — *Phegopteris debilis* METT. Ann. Mus. Bot. Lugd.-Bat. 1 (1864) 123, t. 6 f. 1; v.A.v.R. Handb. (1908) 501. — *Dryopteris debilis* (METT.) C. CHR. Ind. Fil. (1905) 260. — *Cyclosorus debilis* (METT.) COPEL. Gen. Fil. (1947) 142, non CHING 1941. — *Thelypteris debilis* (METT.) REED, Phytologia 17 (1968) 270. — Type: ZIPPELIUS, Amboina (L).

Caudex short, erect; stipe 3–4 cm long. Lamina 30–40 cm long, gradually attenuate both to base and apex; basal pinnae 5 mm long; texture thin. Largest pinnae 3.0 cm long, 0.7 cm wide above base; base truncate, 1.0 cm wide, auricled on acroscopic side, slightly dilated on basiscopic, distal part gradually narrowed to a rounded apex, edges slightly crenate; costules 2.5 mm apart; veins 2 pairs, lower pair anastomosing; sparse hairs 1 mm long on lower surface of rachis, sparse minute hairs on costae and costules, small spherical glands throughout; minute suberect hairs and glands between veins on upper surface. Sori inframedial, small, exindusiate; sporangia bearing 1–2 short setae and sometimes a gland distally and a sessile gland on the stalk.

Distr. *Malesia*: Moluccas (Amboina, without collector's name at B, K, L, also one cult. Hort. Bog. at L); W. New Guinea.

Ecol. In New Guinea on rocks by river at 100 m.

Note. The New Guinea specimens (KANEHIRA & HATUSIMA 12837) have lamina 30 cm long with 50 pairs of pinnae, largest pinnae 2.0 cm long, 0.4–0.5 cm wide above base, basal pinnae 3 mm long; a few long hairs are present on lower surface of costae.

**2. *Sphaerostephanos sudesticus* HOLTUM, sp. nov.**

Pinnae redactae verisimiliter nullae; lamina 54 cm longus; pinnae 15-jugatae, maximae  $17 \times 2.2$  cm, basi late cuneatae,  $3/5$  costam versus

lobatae, utrinque pilis minutis erectis glandisque praeditae; venae 9-jugatae, basales solum anastomosantes; sori mediales, inferiores praesertim elongati, indusiis tenuibus breviter hirsutis et glandulosis tecti; sporangia setifera. — Type: BRASS 27772. Sudest Island, Louisiade Archipelago, terrestrial in openings in forest, alt. 2 m (L).

Caudex not known; stipe 47 cm long, minutely hairy. Reduced pinnae not seen; if present, minute and few. Lamina 54 cm long; pinnae 15 pairs, alternate; 3–4 pairs upper pinnae adnate to rachis with asymmetric bases; lowest pinnae 2.5 cm wide. Rachis minutely hairy on lower surface, hairs on upper surface pale, less than 0.5 mm long. Middle pinnae to  $17 \times 2.2$  cm, base broadly cuneate, aerophores not swollen, apex with cauda 2 cm long, edges lobed to 3.5–4 mm from costa (less than  $2/3$ ), lobes slightly falcate; costules 5 mm apart, at  $60^\circ$ ; veins to 9 pairs, 1 pair anastomosing, next acroscopic vein to sinus-membrane; hairs on lower surface of costae 0.2 mm long, slightly antrorse, a little longer distally, similar shorter hairs more sparse on costules, veins and between veins, glands present throughout; hairs on upper surface of costae 0.2 mm long, scattered hairs 0.5 mm long on costules and veins, very short erect hairs and glands between veins. Sori medial, almost all elongate, lower ones longest; indusia very thin, rather large, bearing sparse short hairs and several glands; sporangia bearing 1–2 short setae.

Distr. *Malesia*: Papua New Guinea (Sudest I.), only known from the type.

Ecol. Terrestrial in openings in forest at 2 m.

**3. *Sphaerostephanos polycarpus* (BL.) COPEL. Un. Cal. Publ. Bot. 16 (1929) 60; Fern Fl. Philip. (1960) 379. — *Aspidium polycarpon* BL. Enum. Pl. Jav. (1828) 156. — *Didymochlaena polycarpa* (BL.) BAK. Syn. Fil. (1867) 248; RACIB. Fl. Btzig 1 (1898) 197. — *Nephrodium polycarpum* (BL.)**

KEYS. Pol. Cyath. Herb. Bung. (1873) vii; BEDD. Handb. Suppl. (1892) 74. — *Mesochlaena polycarpa* (BL.) BEDD. Ferns Br. Ind. Suppl. (1876) 13; Handb. (1883) 199; v.A.v.R. Handb. (1908) 232. — *Dryopteris polycarpa* (BL.) CHRIST, Philip. J. Sci. 2 (1907) Bot. 202. — *Cyclosorus polycarpus* (BL.) HOLTUM, Rev. Fl. Malaya 2 (1955) 283. — *Thelypteris polycarpa* (BL.) K. IWAT. Mem. Coll. Sci. Univ. Kyoto B, 31 (1964) 32. — Type: BLUME, Noesa Kambangan, Java (L).

*Aspidium heterodon* BL. Enum. Pl. Jav. (1828) 157. — Type: from Celebes, no collector cited (L).

*S. asplenoides* J. SM. in Hook. Gen. Fil. (1839) t. 24; KUNZE, Farnkr. 1 (1840) t. 11, 12. — *Mesochlaena asplenoides* J. SM. in Hook. J. Bot. 3 (1840) 18. — *Stegnogramma asplenoides* (J. SM.) FÉE, Gen. Fil. (1852) 204. — Type: origin unrecorded (BM in Herb. J. Sm.).

*Mesochlaena javanica* R. BR. ex METT. Fil. Hort. Lips. (1856) 96, t. 18 f. 13. — *Aspidium javanicum* METT. Farngratt. IV (1858) 103. — *Nephrodium javanicum* (METT.) HOOK. Fil. Exot. (1859) t. 62. — Type: "Java" (not seen).

*Lastrea microchlamys* DE VRIESE, Tijdschr. Wisk.-Nat. Wet. Amst. 1 (1848) 155. — Type: Cult. Hort. Bot. Lugd.-Bat. (L).

*Nephrodium microchlamys* BAK. J. Linn. Soc. Bot. 15 (1876) 107. — Type: MOSELEY, Challenger Exp. Kei Isl. (K).

*Aspidium perakense* BEDD. J. Bot. 26 (1888) 4. — *Nephrodium perakense* (BEDD.) BAK. Ann. Bot. 5 (1891) 319; BEDD. Handb. Suppl. (1892) 80. — *Thelypteris perakensis* (BEDD.) REED, Phytologia 17 (1968) 303. — Type: J. DAY, Perak, Birch's Hill, on exposed rocks (K; E).

*Mesochlaena toppingii* COPEL. Philip. J. Sci. 12 (1917) Bot. 57; C. CHR. Gard. Bull. Str. Settl. 7 (1934) 254. — *S. toppingii* (COPEL.) C. CHR. Ind. Fil. Suppl. III (1934) 172. — Type: TOPPING 1902, Mt Kinabalu (Herb. Am. Fern Soc.).

*S. unijugus* COPEL. Philip. J. Sci. 60 (1936) 109, t. 15. — Type: BRASS 2692, Solomon Is., San Cristobal (UC; BRI, MICH). — Fig. 12a-c.

*Caudex* erect; *stipe* c. 10 cm long, bearing many narrow scales 10 mm long. *Reduced pinnae* 20 pairs or more, 2.5–3.5 cm apart, lowest 1 cm long, uppermost 2.5–3 cm, spreading, triangular with broad base dilated almost equally both sides and acute apex, edges of larger ones incised. *Lamina* above reduced pinnae 100–150 cm long; pinnae many pairs, rather close; basal pinnae not narrowed at base, areophores slightly swollen. *Largest pinnae* commonly 25 × 1.8 cm, largest seen 35 × 2.5 cm; base rather asymmetric, basal acroscopic lobe often elongate; edges lobed more than  $\frac{1}{2}$  way to costa; lobes slightly oblique, slightly falcate; costules commonly to 4 mm apart; veins 12–15 pairs, basal pair anastomosing with excurrent vein to sinus, 1–2 pairs passing to sides of sinus-membrane (in smaller fronds sometimes

only acroscopic vein); *lower surfaces* bearing glands throughout, acicular hairs on rachis, costae and costules normally short, spreading, in some specimens to 1 mm long; acicular hairs on *upper surface* of costae to 1 mm long, scattered similar hairs on costules and veins, between veins a variable number of glands and very short erect acicular hairs. *Sori* medial, elongate, commonly 1 mm long; indusia with many yellow glands; sporangia also bearing glands; spores with a moderate number of wings of varying size.

Distr. Peninsular Thailand; throughout *Malasia* except Philippines north of 10° and Lesser Sunda Islands east of Lombok; Solomon Islands, Samoa.

Ecol. In open not too dry places, in low country and to 1500 m.

Notes. Quite small plants may be fertile; in these sometimes the second veins may both reach the margin above base of sinus. Specimens with long hairs on the lower surface do not differ from the normal condition in other ways, and length of hairs varies; there is no evident correlation of long hairs with drier habitats, but this is possible.

*Aspidium perakense* BEDD. was based on young sterile plants growing on a rock; they are very hairy. DAY collected with them fragments of a fertile frond of an abnormal *Christella*; this is the source of BEDDOME's description of sori.

*Mesochlaena toppingii* COPEL. was based on a small hairy specimen. *S. unijugus* was also based on a small specimen in which at most the second acroscopic vein passes to the sinus-membrane; the upper surface was almost or quite glandless but similar specimens from New Britain have many glands. Another specimen from the Solomon Islands, otherwise similar, has a fair number of glands on the upper surface.

4. *Sphaerostephanos eminens* (BAK.) HOLTUM, comb. nov. — *Nephrodium eminens* BAK. J. Bot. 18 (1880) 213. — *Dryopteris eminens* (BAK.) C. CHR. Ind. Fil. (1905) 263; v.A.v.R. Handb. (1908) 214. — Type: BECCARI 455, Sumatra, G. Singgalang 1700 m (FI; K).

*Dryopteris pilosquamata* var. *obtusata* v.A.v.R. Bull. Jard. Bot. Btzig II, 16 (1914) 12; Handb. Suppl. (1917) 182. — Type: MATTHEW 645, G. Singgalang (BO).

*Mesochlaena talamauiensis* v.A.v.R. Bull. Jard. Bot. Btzig II, 28 (1918) 34. — *S. talamauiensis* (v.A.v.R.) C. CHR. Ind. Fil. Suppl. III (1934) 172. — Type: BÜNNEMEIJER 873, Sumatra, Talamau, 1750 m (BO).

*Caudex* erect or suberect. *Stipe* c. 50 cm long, glabrous; base of stipe to first large pinna 110 cm, this part bearing 7 pairs widely-spaced *reduced pinnae*, upper ones broadly triangular, 2.2 cm long and wide, lowest hardly 1 cm long. *Lamina* to 90 cm long, pinnae 16 pairs, lowest almost sessile and slightly narrowed at base, middle ones with stalks 3–12 mm long; apex of frond almost pinna-

like; aerophores not swollen. *Largest pinnae*  $30 \times 3$  cm, base cuneate, apex long-acuminate, lobed about  $\frac{1}{2}$  way to costa, lobes distinctly falcate, blunt, entire; costules 7 mm apart at  $60^\circ$ ; veins to 12 pairs, concolorous and prominent on lower surface but not above, basal  $1-1\frac{1}{2}$  pairs anastomosing, 2 pairs to sides of sinus-membrane; pale curved hairs  $0.2-0.5$  mm long on lower surface of rachis and costae, shorter and somewhat antrorse on costules, glands (no hairs) on veins and surface between veins; hairs  $0.5$  mm long on upper surface of rachis and costae, much shorter on costules, glands present between veins. *Sori* medial, lower ones somewhat divergent, all except distal ones  $\pm$  elongate; indusia and sporangia bearing glands.

Distr. *Malesia*: Middle to northern Sumatra, several collections.

Notes. The length of pinna-stalks varies in different specimens; those of the type of *M. talamaiensis* only 3 mm, on BECCARI's type 12 mm, on a specimen of MATTHEW's from the same locality 5 mm. YATES 699 from Brastagi is rather intermediate between this species and *S. penniger*, with sessile pinnae and setiferous sporangia.

**5. *Sphaerostephanos williamsii* (COPEL.) HOLTUM**, *Kalikasan* 4 (1975) 53. — *Dryopteris williamsii* COPEL. *Brittonia* 1 (1931) 67, pl. 1. — *Thelypteris williamsii* CHING, *Bull. Fan Mem. Inst. Biol. Bot.* 10 (1941) 255. — *Lastrea williamsii* COPEL. *Gen. Fil.* (1947) 140; *Fern Fl. Philip.* (1960) 322. — Type: R. S. WILLIAMS 2216, Mindanao, San Ramon (UC; B, G, NY, US).

*Caudex* short, erect. *Stipe* 10 cm long, very short-hairy, basal scales 2 mm long, ovate; base of stipe to first normal pinna 20–30 mm. *Reduced pinnae* 3 pairs, not opposite, irregularly spaced, lowest 4 mm long; transition to normal pinnae abrupt or with one pair intermediate. *Lamina* of type 30 cm long (of NY isotype 40 cm); pinnae 12–14 pairs, 1–2 lower ones narrowed at base; aerophores not enlarged. *Largest pinnae* of type  $6.5 \times 1.1$  cm (of NY isotype  $11 \times 1.8$  cm) lobed to less than 1 mm from costa, apex acuminate; lobes oblique, slightly falcate; costules  $2.5-3.5$  mm apart, at  $60^\circ$ ; veins 8–10 pairs, both basal veins ending above base of sinus; acicular hairs on lower surface of rachis and costae short, spreading; whole lower surface of pinna covered with short slender erect hairs and glands; upper surface minutely hairy and glandular throughout. *Sori* medial, exindusiate; sporangia bearing many small yellow glands, less often 2–3 short setae; spores with thin translucent wing and cross wings.

Distr. *Malesia*: Philippines (Mindanao, at 150 m), only known from the type.

**6. *Sphaerostephanos stenodontus* (COPEL.) HOLTUM**, *Kalikasan* 4 (1975) 56. — *Cyclosorus stenodontus* COPEL. *Philip. J. Sci.* 81 (1952) 28, t.

20; *Fern Fl. Philip.* (1960) 344. — *Thelypteris stenodontus* REED, *Phytologia* 17 (1968) 315. — Type: RAMOS & EDANO BS 30849, Panay (US).

*Caudex* not known; base of stipe lacking. *Reduced pinnae* at least 5 pairs, lowest 3–4 mm long; transition to normal pinnae subabrupt. *Lamina* 50 cm long; pinnae 30 pairs, lower ones not narrowed at base. *Largest pinnae* 10 cm long, 1.5 cm wide at dilated base, short-acuminate, lobed  $3/5$  towards costa, lobes slightly oblique, not falcate; costules  $2.5-3$  mm apart, at more than  $60^\circ$ ; veins 8–9 pairs, 1 pair anastomosing, next across-copic vein to short sinus-membrane; hairs more than 1 mm long on lower surface of rachis, fewer with shorter ones on costae and costules, glands all over surface; scattered long hairs on upper surface of costules and veins, short slender appressed hairs and a few glands between veins. *Sori* medial, lacking indusia, basal ones not divergent; sporangia bearing glands.

Distr. *Malesia*: Philippines (Panay), only known from the type.

**7. *Sphaerostephanos flavoviridis* HOLTUM, sp. nov.**

*Pinnae redactae* 2–3-jugatae, superiores 1–2 cm longae; lamina 120 cm longa; pinnae inferiores basi angustatae; pinnae maximae  $21 \times 2.5$  cm, profunde lobatae; venae 12–14-jugatae, infimae anastomosantes; costae subtus pilis minutis praeditae; pagina inter venas utrinque copiose glandulosa; sori mediales, exindusiati; stipites sporangiorum pilis glanduliferis praediti. — Type: JERMY 3694, N.E. New Guinea, Butemu, Morobe Distr. on steep bank in open place (BM).

*Caudex* not known. *Stipe* 30 cm long, glabrous. *Reduced pinnae* variable, 2–3 pairs on 13 cm length of rachis, lowest very small, uppermost 1–2 cm long. *Lamina* 120 cm long, somewhat yellow-green when dry; basal pinnae much narrowed at base, next two pairs less so; aerophores not elongate. *Middle pinnae* to  $21 \times 2.5$  cm, almost sessile, base broadly cuneate to subtruncate, apex with cauda 3 cm long, lobed to  $2.5-3$  mm from costa, lobes hardly falcate, oblong; costules 5 mm apart, at more than  $60^\circ$ ; veins 12–14 pairs, basal pair anastomosing with short excurrent vein to sinus, next pair to sides of short sinus-membrane; hairs on lower surface of rachis and costae minute, on costules  $0.2$  mm long, longer on sinus-membrane and edge, glands throughout lower surface; long antrorse hairs on upper surface of costae, short on costules and veins, glands and minute hairs between veins. *Sori* medial, basal ones divergent; no indusia seen; sporangia lacking glands or setae on body, hairs on stalks with glandular end-cell; spores with many small wings.

Distr. *Malesia*: Papua New Guinea. Known only from type and another specimen from same locality.

**8. *Sphaerostephanos trimetralis* HOLTUM, sp. nov.**

*Caudex erectus, brevis; stipes 10 cm longus, e basi stipitis usque pinna normalis infima 150 cm; pinnae redactae 30-jugatae, late triangulares; lamina 150 cm longa; pinnae maximae 14 × 1.3 cm, crenatae; venae 6-7-jugatae; rachis costaeque subtus pilis 0.2 mm longis adpressis praeditae; pagina inter venas utrinque glandulosa; sori mediales, indusia pilis brevibus et glandulis praedita; sporangia glandulifera.*—Type: HOOGLAND 3391, Papua, Lake Koena (CANB; K, L).

*Caudex* short, erect. *Stipe* 10 cm long, minutely hairy, basal scales 7 mm long, narrow; base of stipe to lowest normal pinna 150 cm or more. *Reduced pinnae* c. 30 pairs, sub-opposite, 4-6 cm apart, broadly deltoid with symmetric base, upper ones 2 × 1.8 cm, crenate, apex acute. *Lamina* 150 cm long; pinnae subcoriaceous, drying light red-brown; aerophores not enlarged. *Largest pinnae* 14 × 1.3 cm, base truncate, apex acuminate, edges crenate to depth of 1 mm or little more; costules 3 mm apart, at more than 60°; veins 6-7 pairs, 2½ pairs anastomosing to form a zig-zag excurrent vein, 1 pair to short sinus-membrane; lower surface of rachis, costae and costules covered with pale antrorse hairs 0.2 mm long, a few short hairs and many glands between veins; hairs on upper surface of costae 0.5 mm long, between veins short erect hairs and glands. *Sori* medial; indusia thin, bearing short hairs and glands; sporangia with glands; spores minutely papillose.

*Distr.* Malesia: Papua New Guinea. Only known from the type.

*Ecol.* Near shore of lake, in marshy vegetation of tall grasses and sedges, alt. 10 m.

**9. *Sphaerostephanos alatellus* (CHRIST) HOLTUM, comb. nov.**—*Nephrodium alatellum* CHRIST in K. Schum. & Laut. Fl. Schutzgeb. (1900) 112. — *Aspidium alatellum* (CHRIST) CHRIST, Bull. Herb. Boiss. II, 1 (1901) 454. — *Dryopteris alatella* (CHRIST) C. CHR. Ind. Fil. (1905) 251; v.A.v.R. Handb. (1908) 210. — *Cyclosorus alatellus* (CHRIST) COPEL. Gen. Fil. (1947) 142; Philip. J. Sci. 78 (1951) 445, excl. syn. *Dryopteris stenobasis* C. CHR., *D. logavensis* ROSENST. & *D. pseudostenobasis* COPEL.—Type: LAUTERBACH 2354, N.E. New Guinea, 600 m(B).

*Cyclosorus heterocarpus sensu* HOLTUM & ROY, Blumea 13 (1965) 134. — **Fig. 13a-c.**

*Caudex* short, erect. *Stipe* 15 cm long, basal scales thin, to 7 × 2 mm; base of stipe to first large pinna 40-60 cm. *Reduced pinnae* 4-6 pairs, very small. *Lamina* dimorphous, to 60 cm long; pinnae 20 pairs or more, texture thin, aerophores not elongate, basal pinnae somewhat narrowed at base. *Largest sterile pinnae* 20 × 2.6 cm, fertile to

14 × 1.4 cm; base unequally broadly cuneate, apex short-acuminate, edges lobed 2/3-3/4 to costa, lobes slightly falcate with rounded tips; costules of sterile fronds 4.5-5 mm apart, of fertile 3.5-4.5 mm; veins 8-9 pairs (sterile) 6-8 pairs (fertile), basal pair spreading at a wide angle to costule and anastomosing with a short excurrent vein or sometimes meeting just below sinus; next veins both to edge; lower surface quite hairless or with some very short hairs on costa only, glands abundant; hairs on upper surface of costae short, very short and sparse on costules, between veins many glands. *Sori* medial; indusia small, glandular; sporangia bearing glands.

*Distr.* Malesia: Widely in Eastern New Guinea, in forest at 400-1300 m.

*Notes.* CHRIST described only a fertile frond and noticed neither glands nor reduced pinnae. COPELAND confused this species with *Amphineuron attenuatum* (O. KTZE) HOLTUM in the Philippines (Fern Fl. Philip. 341) and with *Dryopteris logavensis* ROSENST. (*Amphineuron pseudostenobasis* (COPEL.) HOLTUM) in New Guinea. HOLTUM and ROY misidentified a cultivated plant as *Cyclosorus heterocarpus* and reported a chromosome count 2n = 72.

**10. *Sphaerostephanos daymanianus* HOLTUM, sp. nov.**

*Caudex erectus, 30-40 cm altus; stipes usque 30 cm longus; pinnae redactae c. 6-8-jugatae, superiores 1.5-2.5 cm longae, integrae, aerophorae vix 1 mm longae; lamina 150 cm longa; pinnae maximae 25 × 2 cm vel majores, usque 1/3 costam versus lobatae; venae 9-jugatae, 1-1½-jugatae anastomosantes; pagina utrinque inter venas glandulosa; sori inframediales, inferiores leviter divergentes et leviter elongati; indusia glabra, glandulosa; stipites sporangiorum pilis glanduliferis praediti.*—Type: BRASS 23557, Papua, Milne Bay District, Mt Dayman (BM; A, L, LAE).

*Caudex* erect, 30-40 cm tall, 4-5 cm diam. (BRASS). *Stipe* to 30 cm long, base covered with broad thin scales 10-15 mm long; base of stipe to first large pinna 70 cm or more. *Reduced pinnae* 6-8 pairs, uppermost 1.5-2.5 cm long, broadly triangular, lowest less than 1 mm long. *Lamina* 150 cm long; lower 3-4 pairs normal pinnae gradually narrowed and more shallowly lobed towards base; aerophores hardly 1 mm long. *Largest pinnae* of type 25 × 2.0 cm (of BRASS 23226 36 × 2.4 cm), base subtruncate, apex caudate-acuminate (cauda 3-4 cm), lobed 1/3-2/5 to costa, lobes slightly falcate; costules 4.5 mm apart (to 6 mm in BRASS 23226) at more than 60°; veins to 9 pairs, 1-1½ pairs anastomosing, 1½-2 pairs to sinus-membrane; all lower surfaces glandular throughout, no acicular hairs; hairs on upper surface of costa 0.5 mm long, very short on costules, glands on all parts of surface. *Sori* inframedial, lower ones slightly divergent and slightly elongate;

indusia thin, bearing glands only; sporangia lacking glands on body, hairs on stalks with terminal gland which is red in young sori.

Distr. *Malesia*: Eastern New Guinea (Milne Bay and Morobe Districts), Bougainville.

Ecol. In forest at 700–1500 m.

Notes. PULLEN 7964 (Milne Bay Distr.) has pinnae to 2.6 cm wide, lobed a little more than  $\frac{1}{2}$ , with veins to 13 pairs.

WOMERSLEY & MILLAR 8373 (Morobe Distr.) is reported to have had a caudex 150 cm tall; its sori are young and not elongate.

CRAVEN & SCHODDE 277 from Bougainville had a caudex 60 cm tall, base of stipe to first large pinna 95 cm, fronds in all 3.25 m long; my record is that it has glands on body of sporangia, which needs checking.

**11. *Sphaerostephanos appendiculatus* (BL.) HOLTUM**, *Kalikasan* 4 (1975) 62. — *Gymnogramme appendiculata* BL. Enum. Pl. Jav (1828) addendum to p. 112; Fl. Jav. Fil. (1828) 92, t. 39. — *Goniopteris appendiculata* (BL.) PRESL, Tent. Pterid. (1836) t. 7, f. 11. — *Aspidium pilosiusculum* METT. Ann. Mus. Bot. Lugd.-Bat. 1 (1864) 233, nom. nov. — *Nephrodium appendiculatum* (BL.) RACIB. Fl. Btzig 1 (1898) 186. — *Dryopteris appendiculata* (BL.) C. CHR. Ind. Fil. (1905) 252; v.A.v.R. Handb. (1908) 213; BACKER & POSTH. Varenfl. Java (1939) 52, f. 9. — *Thelypteris appendiculata* (BL.) REED, Phytologia 17 (1968) 260. — Type: BLUME, Java, Boerangrang (L).

*Dryopteris perakensis* var. *sumatrensis* v.A.v.R. Bull. Jard. Bot. Btzig II, 11 (1913) 13. — Type: MATTHEW 516, Sumatra, Padang Pandjang (BO; K).

*Dryopteris brunnescens* C. CHR. Bot. Jahrb. 66 (1933) 44. — *Thelypteris brunnescens* REED, Phytologia 17 (1968) 265. — Type: KJELLBERG 3534, S. W. Celebes, Rante Lemo (S-PA; BO).

Caudex short-creeping. Stipe short, densely short-hairy; base of stipe to first large pinna 15–40 cm. Reduced pinnae 6–12(–20) pairs, somewhat deflexed, lowest 3–5 mm long, upper ones 1 cm long, broadly triangular with asymmetric base. Lamina 20–45(–70) cm long, reddish when young; apical lamina deeply lobed with gradual transition to upper pinnae, several pairs of which are adnate; free pinnae 10–20 pairs, oblique with upturned tips. Largest pinnae commonly to 8.5 × 1.5 cm (to 17 × 2.2 cm); base truncate and distinctly auricled on acroscopic side (bases of upper ones asymmetric), apex short-acuminate, lobed  $\frac{1}{2}$  way to costa (largest ones more than  $\frac{1}{3}$ ); lobes oblique with falcate obtusely angled tips; costules 3.5 mm apart in small frond, to 5 mm in large ones; veins 6–7(–9) pairs, one pair anastomosing, next pair to sinus-membrane; lower surface of costae and rachis bearing short and long spreading hairs, sparse on costules and veins, very short hairs and

glands between veins; short hairs on upper surface of costae, very short erect hairs abundant between veins, usually some glands also. Sori medial, lower ones not divergent; indusia small with glands and short hairs; sporangia with several setae (to 10), sometimes also a gland.

Distr. *Malesia*: Sumatra, Java, Lesser Sunda Is. (Bali, Flores), SW. & N. Celebes, Philippines (Luzon).

Ecol. On rocks by streams or waterfalls at 400–1200 m.

Notes. *D. brunnescens* was based on a small plant with pinnae to 4.5 cm long. PRICE reports red young fronds on plants in Luzon but I have seen no such report from Java.

**12. *Sphaerostephanos pseudomegaphyllus* (v.A.v.R.) HOLTUM**, *comb. nov.* — *Dryopteris megaphylloides* v.A.v.R. Bull. Jard. Bot. Btzig II, 20 (1915) 16, non ROSENST. 1913. — *Dryopteris pseudomegaphylla* v.A.v.R. Handb. Suppl. (1917) 180. — Type: BURCK, Sumatra, Padang Pandjang (BO).

*Aspidium megaphyllum* var. *hirsutum* METT. Ann. Mus. Bot. Lugd.-Bat. 1 (1864) 233; MIQUEL, *ibid.* 4 (1869) 159. — Type: KORTHALS, Sumatra (L).

Differs from *S. penniger*: fronds smaller; pinnae 7 × 1 to 16 × 2.2 cm, lobed about 1/4–1/3 to costa; veins 8–10 pairs, 1½–2 pairs anastomosing, 1½ pairs to sides of sinus-membrane; dense spreading hairs to 0.5 mm long on lower surface of rachis and costae; indusia densely hairy or with many glands and fewer hairs; sporangia copiously setiferous.

Distr. *Malesia*: Sumatra (Padang Highlands).

**13. *Sphaerostephanos diversilobus* (PRESL) HOLTUM**, *Kalikasan* 4 (1975) 57. — *Nephrodium diversilobum* PRESL, Epim. Bot. (1851) 47; HOLTUM, Novit. Bot. Univ. Carol. Prag. 1968 (1969) 39. — *Dryopteris diversiloba* (PRESL) CHRIST, Philip. J. Sci. 2 (1907) Bot. 199, *nomen tantum*; COPEL. Philip. J. Sci. 40 (1929) 297. — *Phegopteris diversiloba* (PRESL) v.A.v.R. Handb. (1908) 503. — *Cyclosorus diversilobus* (PRESL) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 244; COPEL. Fern Fl. Philip. (1960) 357. — *Thelypteris diversiloba* (PRESL) REED, Phytologia 17 (1968) 273. — Lectotype (HOLTUM 1969): CUMING 102, Luzon (PRC; E, FI-W, G, K, LE). *Goniopteris asymmetrica* FÉE, Gen. Fil. (1852) 253. — *Thelypteris asymmetrica* (FÉE) REED, Phytologia 17 (1968) 261. — Specimens cited: CUMING 51, 102; FÉE's specimens of these numbers not seen.

*Dryopteris acromanes* CHRIST, Philip. J. Sci. 2 (1907) Bot. 200. — *Phegopteris acromanes* (CHRIST) v.A.v.R. Handb. (1908) 505. — Type not selected; specimens cited (which include one of CUMING 51) not seen.

Caudex short, creeping. Stipe of sterile frond to



20 cm, of fertile to 30 cm, sparsely hairy. *Reduced pinnae* 2 pairs, very small, seen in isotype at E only. *Lamina* 25 cm long; pinnae 7-9 pairs; basal pinnae gradually narrowed at base, basal basiscopic lobe missing. *Fertile pinnae* to  $6.5 \times 2.0$  cm, sterile to 8 cm long, 3 cm wide near apex; lower pinnae and sometimes others widened and more deeply lobed distally, some with irregularly elongate subapical lobes. *Middle pinnae* with  $\pm$  dilated base, abruptly short-pointed apex, lobed 2/3 to costa apart from widened apical part, lobes hardly falcate, normally entire; costules 4-5 mm apart; veins 7-8 pairs except in elongate distal lobes, 1 pair anastomosing, next acroscopic vein to sinus-membrane; lower surface of rachis and costae bearing short erect acicular hairs, also some longer ones, especially on sterile pinnae; short erect hairs between veins on both surfaces, glands few on both surfaces, those on lower surface usually confined to costules and veins. *Sori* medial; indusia thin, densely hairy with a few glands; sporangia with glands; spores with translucent wing and cross-wings.

Distr. *Malesia*: Philippines (Luzon, Panay), in forest at 300-1000 m.

Notes. Some pinnae are irregularly lobed on most specimens; this suggests hybridization. One sterile frond of CUMING 51 at Kew has very long distal lobes which are crenate with pleocnemoid venation. The only specimen seen with reduced basal pinnae is one of CUMING 102 at Edinburgh. The specimens listed by CHRIST in 1907 under *D. diversiloba* represent several other species; he re-described PRESL's species as *D. acromanes* from CUMING 51 and other specimens now apparently lost.

**14. *Sphaerostephanos dichrotrichus* (COPEL.) HOLTUM, comb. nov.** — *Dryopteris dichrotricha* COPEL. Philip. J. Sci. 6 (1911) Bot. 74. — *Thelypteris dichrotricha* (COPEL.) REED, Phytologia 17 (1968) 272. — Type: C. KING 294, Papua "mainland opposite Samarai island" (MICH; BRI, NSW).

*Caudex* short-creeping. *Stipe* 40 cm to first reduced pinna, dull reddish with pale hairs 0.5 mm or more long. *Lamina* 65 cm or more long; pinnae to 20 pairs, basal 1-3 pairs gradually reduced, lowest 1-4 cm long; aerophores slightly swollen. *Largest pinnae*  $18 \times 2.0$  cm; base truncate, apex acuminate with entire cauda to 1.5 cm long; edges lobed  $\approx \frac{1}{2}$  way to costa, lobes slightly falcate with round tips; costules 4.5-5 mm apart, at  $60^\circ$  or more; veins 7 pairs, 1-1 $\frac{1}{2}$  pairs anastomosing, next  $\frac{1}{2}$ -1 pair to sinus-membrane; rather sparse hairs 1 mm long and many shorter ones on lower surface of rachis and costae, shorter on costules and veins, glands and short erect hairs between veins; minute erect hairs and glands between veins on upper surface. *Sori* medial; indusia thin, with many hairs, also glands; sporangia usually with

1-2 slender setae (rarely a gland) on body, on stalk a sessile gland; spores with a thin translucent wing and cross-wings.

Distr. *Malesia*: extreme east of New Guinea, Admiralty Islands, at low altitudes.

Notes. Some specimens have more erect hairs than glands on upper surface. In one (LAE 65333) there are 2 pairs of small pinnae near base of stipe and then a gap of 20 cm.

**15. *Sphaerostephanos vestigiatus* (COPEL.) HOLTUM, comb. nov.** — *Dryopteris vestigiata* COPEL. Un. Cal. Publ. Bot. 18 (1942) 220. — *Cyclosorus vestigiatus* (COPEL.) COPEL. Gen. Fil. (1947) 143; Philip. J. Sci. 78 (1951) 446, pl. 27. — *Thelypteris vestigiata* (COPEL.) REED, Phytologia 17 (1968) 323. — Type: BRASS 12317, W. New Guinea, Idenburg River, 1700 m, in forest (MICH; BM, L).

*Caudex* slender, erect, to 60 cm tall. *Stipe* to 50 cm long, glandular, hairless. *Reduced pinnae* 3 pairs, all very small, 5 cm apart. *Lamina* more than 100 cm long; pinnae 40 pairs, not dimorphous, basal pinnae somewhat narrowed at base, with stalks to 1 mm long, aerophores not swollen. *Largest pinnae*  $21 \times 2.2$  cm, base broadly cuneate, apex caudate-acuminate (cauda 2.5-5.0 cm subentire) lobed to 2-2.5 mm from costa, lobes hardly falcate with rounded tips; costules 4-4.5 mm apart at  $60^\circ$  or more; veins 9-11 pairs, 1 pair anastomosing, next veins both to edge; hairs on lower surface of rachis and costae 0.1 mm long (longer distally on costules), surface between veins copiously glandular; upper surface of costules and veins with scattered hairs like those on costae, between veins minute erect hairs and glands. *Sori* medial or little supramedial; indusia small, thin, with glands only; sporangia bearing glands on body and gland-tipped hairs on stalk; spores with many small wings.

Distr. *Malesia*: Several collections from eastern New Guinea at c. 1500 m.

Note. Some specimens have quite hairless lower surface of rachis and base of costae.

**16. *Sphaerostephanos morotaiensis* HOLTUM, sp. nov.**

*Caudex brevis, repens; stipes 5 cm longus; pinnae redactae usque 12-jugatae, patentes, superiores 1.5-2 cm longae; lamina 50 cm longa; pinnae 16-jugatae, maximae  $7.5 \times 1.5$  cm, subintegerrae; venae 4-5-jugatae; pagina inter venas utrinque pilis minutis erectis glandulisque praedita; sori mediales; indusia brevi-pilosa; sporangia glandulifera.* — Type: MAIN & ADEN 758, Morotai, Totodahu, 30 m (K; BO, L, SING).

*Caudex* short-creeping. *Stipe* 5 cm long, minutely hairy; base of stipe to first normal pinnae 50 cm. *Reduced pinnae* 1.5-2.5 cm apart, to 12 pairs; upper ones 1.5-2 cm long, spreading, broadly triangular, entire; lowest 4 mm long.

*Lamina* 50 cm long; pinnae 16 pairs, lower ones not narrowed at base nor auricled; aerophores not elongate. *Largest pinnae*  $7.5 \times 1.5$  cm; base truncate, sometimes a little dilated; apex short-acuminate; edges subentire; costules 3–3.5 mm apart on fertile pinnae, 4.5 mm on sterile; veins 4–5 pairs,  $3-3\frac{1}{2}$  pairs anastomosing, sinus-membrane hardly detectable; whole lower surface (including rachis) covered with very short erect hairs and glands; hairs on upper surface of costae 0.3–0.4 mm long, on costules and veins sparse, surface between veins with very short erect hairs and glands. *Sori* medial; indusia small with many short hairs; sporangia bearing glands.

Distr. *Malesia*: Moluccas. Apart from the type and other specimens from Morotai, I refer here SA-AANAM 49 from Obi Island (L) which has larger crenate pinnae (to  $18 \times 3.0$  cm), agreeing in other respects.

**17. *Sphaerostephanos kalkmanii* HOLTUM, sp. nov.**

*Caudex erectus*; pinnae redactae 4-jugatae, omnes minutae; pinnae normales 18-jugatae, usque  $3.5 \times 1.0$  cm, crenatae, costae costulaeque subtus pilis minutis appressis glandulisque praeditae; indusia parva vel nulla; sporangia nec glandulis nec setis instructa. — Type: KALKMAN 4070, W. New Guinea, Orion Mts, Tenma River, 1500 m (BM; LAE, L. SING).

*Caudex* erect, to at least 15 cm tall. *Stipe* 4–5 cm long, dark, sparsely short-hairy, basal scales c.  $4 \times 1$  mm; base of stipe to first large pinna 10–15 cm. *Reduced pinnae* to 4 pairs, all about 1 mm long. *Lamina* 20 cm long; pinnae 18 pairs, subcoriaceous, lower ones not narrowed at base; aerophores slightly swollen. Hairs on lower surface of rachis 0.3 mm long, brown, on upper surface a little longer. *Largest pinnae* 2.6–3.5 cm long, 0.7–1.0 cm wide, fertile ones sometimes, not always, smaller than sterile; base subtruncate to broadly cuneate; apex rather abruptly short-pointed; edges crenate, a little more deeply in fertile than in sterile pinnae; costules 2 mm apart; veins all very oblique, 4–5 pairs,  $1\frac{1}{2}$  pairs anastomosing, next vein to short sinus-membrane; lower surface of costae and costules covered with minute appressed hairs, also glands, a few glands sometimes present on surface between veins; hairs on upper surface of costae to 0.5 mm long, on costules and veins shorter, sparse, a few glands sometimes present (?) on surface between veins. *Sori* medial, sometimes covering whole surface at maturity; indusia very small with short hairs and glands, sometimes lacking; sporangia bearing neither glands nor setae; spores minutely spinulose.

Distr. *Malesia*: West New Guinea, 1500 m. Only known from type.

Ecol. "In abandoned garden, rather common".

Note. Possibly nearest to the lowland species *S. lamii*, which has glands between veins on both

surfaces. *S. lamii* has longer pinnae, upper reduced pinnae 10 mm long, and veins not very oblique.

**18. *Sphaerostephanos perglanduliferus* (v.A.v.R.) HOLTUM**, *Kalikasan* 4 (1975) 59. — *Dryopteris perglandulifera* v.A.v.R. *Bull. Jard. Bot. Btzg III*, 2 (1920) 150. — *Thelypteris perglandulifera* (v.A.v.R.) REED, *Phytologia* 17 (1968) 303. — Type: BROOKS 281, Sumatra, Lebong Tandai, Benkoelen (BO).

*D. perglandulifera* var. *firmior* v.A.v.R. l.c. — Type: DOCTERS VAN LEEUWEN-REYNVAAN 3284, Sumatra, Haboko (BO).

*Phegopteris pseudoarfakiana* HOSOKAWA, *Tr. Nat. Hist. Soc. Formosa* 28 (1938) 147. — *Meniscium pseudoarfakianum* (HOSOKAWA) HOSOKAWA, *ibid.* 32 (1942) 286. — Type: HOSOKAWA, Caroline Is., Palau (TAI).

*Dryopteris arbuscula* sensu KJELLBERG & C. *CHR. Bot. Jahrb.* 66 (1933) 43.

*Caudex* massive, short, erect; stipe 5–15 cm long, densely short-hairy; basal scales 10 mm long, narrow; base of stipe to first normal pinna 20–50 cm; reduced pinnae to 10 pairs, lowest  $7 \times 7$  mm, upper ones to  $1.5 \times 1.5$  cm, base broadly cuneate, symmetric, apex obtusely pointed. *Lamina* of type 75 cm long; transition at base to reduced pinnae subabrupt; lowest normal pinnae not auricled at base; aerophores not elongate. *Largest pinnae* of type  $14 \times 1.7$  cm (on small plants, fertile,  $7 \times 1$  cm), base broadly cuneate, apex short-acuminate, edges shallowly crenate; costules 3–4 mm apart, at c.  $45^\circ$  to costa; veins 6–7 pairs, 3 pairs anastomosing to form a slightly zig-zag excurrent vein, 1 pair to sides of sinus-membrane; lower surface of rachis covered with slender appressed hairs less than 0.5 mm long, hairs on costae minute, glands throughout lower surface; hairs on upper surface of rachis pale, 1 mm long, on costae less than 0.5 mm, copious glands between veins. *Sori* medial; indusium bearing glands; sporangia with short setae and glands, a gland at end of short hair on sporangium-stalk.

Distr. *Malesia*: S. Sumatra, Borneo, S.W. Celebes, Philippines (Negros) and Micronesia (Palau).

Ecol. In rocky stream-beds at low to medium altitudes.

Note. This is closely related to *S. penniger*, but appears to be distinct in its erect caudex (seen on several specimens) and narrow crenate pinnae; the stream-bed habitat is recorded for several specimens.

**19. *Sphaerostephanos veitchii* HOLTUM**, *Al-lertonia* 1 (1977) 204. — Type: J. G. VEITCH, Solomon Islands, San Cristobal (K).

*Nephrodium amboinense* var. *subglandulosum* BAKER, *J. Linn. Soc. Bot.* 19 (1882) 295. — Type: R. B. COMINS, Solomon Islands (K).

*Caudex* short, creeping or suberect. *Stipe* of type lacking, of others 10–20 cm, minutely hairy; base of stipe to first large pinna 35–60 cm. *Reduced pinnae* about 7 pairs, lowest 5 mm long, upper ones 1.5–2.5 cm long and wide, broadly triangular with asymmetric base (wider on acroscopic side), crenate. *Lamina* 50–90 cm or more long; basal pinnae not narrowed at base; aerophores not elongate. *Largest pinnae* of type  $13 \times 1.7$  cm, of others to  $20 \times 2$  cm; base broadly truncate to full width, sometimes a little dilated but not auricled; apex acuminate, not caudate; edges crenate to depth of 1–1.5 mm; costules 4 mm apart, at  $60^\circ$  to costa; veins 6 pairs,  $2\frac{1}{2}$  pairs anastomosing to form a zig-zag excurrent vein, 1–2 pairs to sides of sinus-membrane; hairs on lower surface of rachis 0.4 mm long (much shorter on some plants from New Guinea), pale, curved, on costae and costules shorter, antrorse, many glands and short erect hairs between veins; upper surface of rachis covered with brown hairs more than 0.5 mm long, similar hairs on costae and scattered on costules and veins, glands on surface between veins and sometimes short erect hairs. *Sori* medial, lower ones divergent, those on basal veins from adjacent costules sometimes confluent; indusia small, bearing short hairs and glands; sporangia bearing glands.

Distr. Solomon Islands, and Malesia: Eastern New Guinea.

Ecol. In the Solomons by streams in low country and to 800 m; in New Guinea plants in forest at higher altitudes (to 1400 m) are smaller but otherwise not distinct.

## 20. *Sphaerostephanos lamii* HOLTUM, sp. nov.

*Caudex brevis, repens vel suberectus; stipes 20 cm longus; pinnae reductae 3.5-jugatae, superiores 10 mm longae; lamina 30 cm longa, pinnae 12–15-jugatae, dimorphae; pinnae steriles usque  $8.5 \times 1.8$  cm, crenatae, pagina utrinque glandulifera; pinnae fertiles usque  $6.0 \times 1.2$  cm; sori inframediales; indusia parva, pilis brevibus glandulisque praedita; sporangia glandulifera.* — Type: H. J. LAM 748, W. New Guinea, Prauwen bivak, 10 m (L; BO).

*Caudex* short, creeping or suberect; *stipe* 12–20 cm long, short-hairy in groove; base of stipe to first normal pinna 30–40 cm; *reduced pinnae* 3–5 pairs, not opposite, upper ones to 10 mm long, deflexed with slightly auricled asymmetric base, lowest 3 mm long. *Lamina* 30 cm long; pinnae 8–15 pairs, more or less dimorphous, basal pinnae not narrowed at base, not auricled; aerophores not elongate; *rachis* bearing stiff brown hairs to 1 mm long on both surfaces. *Sterile pinnae* to  $8.5 \times 1.8$  cm, base truncate, apex short-acuminate, edges crenate to a depth of 1 mm; costules  $3.5$ – $4$  mm apart, at  $60^\circ$  to costa; veins 5–6 pairs,  $2\frac{1}{2}$  pairs anastomosing, one pair to sides of sinus-membrane; on lower surface hairs at base of costae

very short, distally 0.2–0.3 mm (but see note below), rest of lower surface of pinnae glabrous with sessile glands; hairs on upper surface of costae hardly 0.5 mm long, rest of upper surface glabrous or with some minute hairs, glands present throughout but fewer than on lower surface, sometimes lacking. *Fertile pinnae* to  $6.0 \times 1.2$  cm, slightly crenate; veins 3–4 pairs; sori near costules, basal ones not divergent; indusia small, with very short hairs and a few glands; sporangia bearing glands.

Distr. Malesia: W. New Guinea, several collections from Rouffaer and Mamberamo Rivers, at 10–200 m; Admiralties (Los Negros: GREY & WAGNER 4003); a distinct variety in Eastern New Guinea?

Note. A specimen from 820 m in the Southern Highlands of Eastern New Guinea differs in the presence of hairs 1 mm long on the lower surface of costae and scattered long hairs on costules and veins on the upper surface.

21. *Sphaerostephanos hirsutus* (KUNZE ex METT.) HOLTUM, *Kalikasan* 4 (1975) 63. — *Nephrodium hirsutum* PRESL, *Epim. Bot.* (1851) 48, non D. DON 1825; HOOK. *Sp. Fil.* 4 (1862) 70 p.p. & t. 240B. — *Aspidium hirsutum* KUNZE ex METT. *Farngatt.* IV (1858) 107, nom. nov. — *Dryopteris hirsuta* (KUNZE ex METT.) O. Ktze, *Rev. Gen. Pl.* 2 (1891) 813; v.A.v.R. *Handb.* (1908) 214. — *Dryopteris adenophora* C. Chr. *Ind. Fil.* (1905) 251, nom. nov. *superfl.* — *Cyclosorus adenophorus* (C. Chr.) CHING, *Bull. Fan Mem. Inst. Biol. Bot.* 10 (1941) 242; COPEL. *Fern Fl. Philip.* (1960) 343. — *Thelypteris adenophora* (C. Chr.) REED, *Phytologia* 17 (1968) 258. — Type: CUMING 82, Luzon (PRC; K, P).

### KEY TO THE VARIETIES

1. Pinnae commonly to  $20 \times 2.2$  cm; sporangia glanduliferous . . . . . a. var. *hirsutus*
1. Pinnae to  $15 \times 1.4$  cm; sporangia setiferous . . . . . b. var. *celebicus*

#### a. var. *hirsutus*

*Caudex* short, erect, with many branches at its base; *stipe* short; base of stipe to first normal pinna 30–90 cm, basal scales broad, thin, not persistent; *reduced pinnae* to 12 pairs or more, each consisting of an aerophore with a very small rounded blade, uppermost less than 1 cm long. *Lamina* to 120 cm long; transition at base to reduced pinnae abrupt or with an intermediate pair; lowest normal pinnae somewhat narrowed at their bases and sometimes slightly auricled; aerophores to 1 mm long. *Largest pinnae* commonly  $12$ – $20 \times 1.5$ – $2.2$  cm (to  $30 \times 2.5$  cm, teste COPELAND), base truncate and somewhat dilated; apex caudate-acuminate (cauda 1.5–2.5 cm long), lobed  $2/5$ – $3/5$  towards costa; lobes distinctly fal-

cate with rounded or obtuse-pointed tips; costules 3–4 mm apart, at 60° or more to costa; veins 7–8 pairs, 1 pair anastomosing, next pair to sides of sinus-membrane; lower surface of rachis and costae with a variable number of long coarse hairs (sometimes only distally on costae) with very short hairs and glands, costules similar, abundant glands between veins; hairs on upper surface of rachis and costae 1.5 mm or more long, scattered hairs 1 mm long on costules and veins, between veins abundant appressed hairs and a variable number of glands (often few). *Sori* medial, lower ones not divergent; indusia small, with glands and short hairs; glands on sporangia.

Distr. *Malesia*: throughout Philippines, in forest, at 400–1200 m.

Note. Pubescence in *var. hirsutus* is variable; it is most clearly distinguished from *S. todayensis* (which see), also variable in pubescence, by the small size of its basal reduced pinnae. A more nearly allied species is *S. trichochlamys*.

**b. *var. celebicus* HOLTUM, *var. nov.***

*A typo speciei differt: pinnis usque 15 × 1.4 cm; pagina inferiore inter venas pilis tenuibus adpressis vestita; indusiis nullis vel minutis; sporangiis 3–4 setis ornatis.* — Type: POSTHUMUS 2743, S.W. Celebes, G. Bonthain, 1500 m (BO).

Distr. *Malesia*: S. W. and Central Celebes & Lesser Sunda Is. (Flores: JAAG 1647).

**22. *Sphaerostephanos acrostichoides* (DESV.) HOLTUM, *comb. nov.* — *Nephrodium acrostichoides* DESV. Mém. Soc. Linn. Paris 6 (1827) 255. (Not *Thelypteris acrostichoides* (MICHX) NEWL. *nom. inval.*) — Type: Collector unnamed, Timor (P).**

*Polystichum riedleanum* GAUD. in Freyc. Voy. Ur. Phys. Bot. (1828) 327. — *Dryopteris riedleana* (GAUD.) v.A.v.R. Handb. (1908) 230. — Type: GAUDICHAUD, Timor (G).

*Nephrodium smithianum* PRESL, Epim. Bot. (1851) 46; HOLTUM, Novit. Bot. Inst. Bot. Univ. Carol. Prag. 1968 (1969) 41 *excl. syn.* *Aspidium productum* KAULF. — *S. smithianus* (PRESL) HOLTUM, Kalikasan 4 (1975) 65. — Type: CUMING 279, Guimaras (PRC; B, BM, E, G, K, L).

*Dryopteris perpilifera* v.A.v.R. Bull. Jard. Bot. Btzig II, 11 (1913) 12; Handb. Suppl. (1917) 183. — *Thelypteris perpilifera* (v.A.v.R.) REED, Phytologia 17 (1968) 303. — Type: LAUTERBACH 68, N.E. New Guinea, Finschhafen (BO; BRI, L, SING).

*Dryopteris angusta* COPEL. Philip. J. Sci. 9 (1914) Bot. 3; v.A.v.R. Handb. Suppl. (1917) 186. — *Thelypteris angusta* (COPEL.) REED, Phytologia 17 (1968) 259. — Type: C. KING 408, E. New Guinea (MICH; K, NSW).

*Dryopteris pseudoarbuscula* v.A.v.R. Philip. J. Sci. 11 (1916) Bot. 106; Handb. Suppl. (1917) 504. — Type: C. B. ROBINSON 1962, Amboina (BO; K, L, P).

*Dryopteris riparia* COPEL. Univ. Cal. Publ. Bot. 18 (1942) 221. — *Cyclosorus riparia* (COPEL.) COPEL. Gen. Fil. (1947) 143; Philip. J. Sci. 78 (1951) 456, pl. 37. — *Thelypteris riparia* (COPEL.) REED, Phytologia 17 (1968) 309. — Type: BRASS 13048, New Guinea, Idenburg River, 800 m (UC; BM, BO, L, LAE).

*Cyclosorus boholensis* COPEL. Philip. J. Sci. 81 (1952) 31, pl. 23; Fern Fl. Philip. (1960) 348. — *Thelypteris boholensis* (COPEL.) REED, Phytologia 17 (1968) 204. — Type: RAMOS BS 42990, Bohol (UC; G).

*Cyclosorus reederi* COPEL. Amer. Fern J. 43 (1953) 12. — *Thelypteris reederi* (COPEL.) REED, Phytologia 17 (1968) 308. — Type: REEDER 889, N.E. New Guinea, Finschhafen (US).

*Aspidium arbuscula sensu* CHRIST, Ann. Jard. Bot. Btzig 15 (1898) 135. — *Cyclosorus hispidula sensu* COPEL. Philip. J. Sci. 78 (1951) 455. — *Cyclosorus productus sensu* COPEL. Fern Fl. Philip. (1960) 348, p.p.

*Caudex* erect, not or little branched at the base. Base of *stipe* to lowest reduced pinna 3–10 cm, to lowest large pinna 10–30 cm or more; at base of lamina a subabrupt transition to reduced pinnae; number of reduced pinnae varying with size of frond, larger ones spreading, triangular with a broad base. Lamina of smaller plants fertile at 20 cm long with 15 pairs pinnae, of large plants to 50 cm long. Largest fertile pinnae of small plants 3–5 × 0.7–1.0 cm, of largest plants to 10 × 1.0 cm or larger; base broadly cuneate and ± dilated on both sides, apex evenly tapered, edges lobed 1/3–1/2 way to costa; costules at less than 60° to costa, 2–2½ mm apart in small plants; veins 3–4 pairs in small plants, 7–8 pairs in large ones, 1–1½ pairs anastomosing, next acroscopic vein to sinus membrane; lower surface of rachis with copious spreading pale hairs ½–1 mm long and shorter ones, long hairs less abundant on costae, lower surface between veins bearing copious glands and some erect short hairs; upper surface of rachis with pale hairs 1 mm long, shorter hairs on costae, also scattered on costules and veins, between veins copious short erect hairs and glands. *Sori* medial, on small pinnae covering lower surface; indusia hairy and glandular; sporangia bearing glands.

Distr. *Malesia*: East Java, Lesser Sunda Is. (Sumba, Timor), Central & S.E. Celebes, Philippines (Bohol, Mindanao, Guimaras), Moluccas (Amboina), and New Guinea incl. Admiralty Is.

Ecol. Usually in rocky stream-beds at 0–500 m (to 1500 m in Mindanao and New Guinea). In New Guinea plants of all sizes have been collected, but elsewhere none as large as the larger ones in New Guinea. Types of the various basionyms differ chiefly in size, agreeing well in frond-form, dilated bases of pinnae, pubescence and the distribution of glands. If the larger New Guinea plants (which apparently do not grow in stream-beds) are judged to represent a distinct species, the name *Dry-*

*opteris perpilifera* v.A.v.R. should be its basionym.

**23. *Sphaerostephanos melanorachis* HOLTUM, sp. nov.**

*Stipes* rachisque atrobrunneus; *stipes* 7 cm longus; *pinnae* redactae 10-jugatae, superiores usque 1.7×1.5 cm; *lamina* 55 cm longa; *pinnae* dimorphae, steriles usque 13×1.9 cm, fertiles minores, omnes c. 1/3 costam versus lobatae; *venae* 8-jugatae, 2-jugatae anastomosantes; *rachis* costaeque subtus pilis brevibus antrorsis vestita; *pagina* inter venas utrinque glandulosa; *sori* mediales; *indusia* pilis paucis praedita. — Type: A. H. G. ALSTON 16927, Moluccas, Batjan, Mt Sibela 750 m (BM).

*Caudex* short, apparently erect. *Stipe* 7 cm, dark brown, minutely hairy; base of stipe to first large pinna 35–40 cm; rachis also very dark. *Reduced pinnae* 10 pairs, upper ones 1.7×1.5 cm, triangular with asymmetric base, crenate, slightly deflexed, lowest 4–5 mm long. *Lamina* 55 cm long; *pinnae* 25 pairs, dimorphous; *aerophores* not elongate. *Sterile pinnae* to 13 cm long, 1.9 cm wide above truncate dilated base, apex caudate-acuminate (cauda to 1.5 cm); edges lobed to a depth of 3 mm (c. 1/3), lobes slightly falcate; *costules* 4 mm apart, to 60°; *veins* to 8 pairs, 2 pairs anastomosing, forming a zig-zag excurrent vein, 1 pair to sinus-membrane; *lower surface* of rachis bearing rather sparse pale appressed hairs 0.5 mm long, those on costa also antrorse, 0.2 mm long, sparse short appressed hairs on costules and veins; glands on surface between veins; hairs on *upper surface* of rachis pale, 1 mm long, on costae a little shorter, similar hairs scattered on costules and veins, glands between veins. *Fertile pinnae* to 9.5 cm long, 1.6 cm wide at base, 1.2 cm above base; *sori* medial; *indusia* rather small, thin, with a few short hairs; *sporangia* rarely with a gland.

*Distr. Malesia:* Moluccas (Batjan, Mt Sibela), 750 m.

**24. *Sphaerostephanos heterocarpus* (BL.) HOLTUM** in Nayar & Kaur, Comp. to Bedd. (1974) 209. — *Aspidium heterocarpon* BL. Enum. Pl. Jav. (1828) 155; METT. Ann. Mus. Bot. Lugd. — Bat. 1 (1864) 233. — *Nephrodium heterocarpum* (BL.) MOORE, Ind. Fil. (1858) 93; RACIB. Fl. Btzg 1 (1898) 187. — *Dryopteris heterocarpa* (BL.) O. KTZE, Rev. Gen. Pl. 2 (1891) 813; v.A.v.R. Handb. (1908) 228; C. CHR. Gard. Bull. Str. Settl. 4 (1929) 380; BACKER & POSTH. Varenfl. Java (1939) 54. — *Cyclosorus heterocarpus* (BL.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 8 (1938) 180; HOLTUM, Rev. Fl. Malaya 2 (1955) 269, f. 155; TARD. Fl. Gén. I.-C. 7, pt. 2 (1941) 385; COPEL. Fern Fl. Philip. (1960) 345, p.p. — *Thelypteris heterocarpa* (BL.) MORTON, Amer. Fern J. 49 (1959) 113. — Type: BLUME, Java, *ad pedem* Boerangrang (L, n. 908, 332–1158).

*Polypodium longifolium* ROXB. Calc. J. Nat. Hist. 4 (1844) 462. — Type from Amboina (BR).

*Nephrodium pubescens* BRACK. in Wilkes U.S. Expl. Exp. 16 (1854) 186, non DON 1825. — Type: U.S. Expl. Exp. Luzon, near Banos (US).

*Dryopteris bordenii* CHRIST, Philip. J. Sci. 2 (1907) Bot. 204; v.A.v.R. Handb. (1908) 822. — *Cyclosorus bordenii* (CHRIST) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 243; COPEL. Fern Fl. Philip. (1960) 345, p.p. — *Thelypteris bordenii* (CHRIST) REED, Phytologia 17 (1968) 264. — *S. heterocarpus* var. *bordenii* HOLTUM, Kalikasan 4 (1975) 67. — Lectotype (HOLTUM 1975): BORDEN 1237, Luzon, Mt Mariveles (US).

*Dryopteris suprastrigosa* ROSENST. Fed. Rep. 10 (1912) 335. — *Cyclosorus suprastrigosus* (ROSENST.) COPEL. Gen. Fil. (1947) 143; Philip. J. Sci. 78 (1951) 446. — *Thelypteris suprastrigosa* (ROSENST.) REED, Phytologia 17 (1968) 318. — Type: Frau BAMLER 37, N.E. New Guinea, Sattelberg (not seen; at BM is KEYSER 37 from Sattelberg, named by ROSENST.).

*Dryopteris mixta* ROSENST. Fed. Rep. 12 (1913) 172. — *Lastrea mixta* (ROSENST.) COPEL. Philip. J. Sci. 78 (1951) 426. — *Thelypteris mixta* (ROSENST.) REED, Phytologia 17 (1968) 293. — Type: KEYSER S. 141, N.E. New Guinea, Sattelberg (S-PA). — Fig. 1q.

*Caudex* erect, rarely very tall, usually with several branches from base. *Stipe* 5 cm or little more. *Reduced pinnae* commonly 10 pairs (distance apart, and number, depending on size of plant), never less than 6 pairs, uppermost commonly 10 mm long, narrow, auricled, lowest very small. *Lamina* variable in length; *pinnae* commonly 20–30 pairs; several pairs lower *pinnae* much narrowed towards their bases, basal one at most slightly auricled; *aerophores* slightly swollen. *Largest pinnae* 10–20 cm long, 1.2–2.5 cm wide, fertile sometimes narrower than sterile and with shorter hairs, lobed 5/8–3/4 towards costa; *costules* 3–3½ mm apart; *veins* 6–12 pairs, basal veins anastomosing at least in basal half of pinna with excurrent vein to sinus, second acroscopic vein sometimes touching side of sinus-membrane; hairs on *lower surface* of costae very short, erect, with scattered longer ones usually not over 0.5 mm long, more sparse similar hairs on costules and veins, copious yellow glands and a variable number of short erect hairs between veins; *upper surface* of costae bearing antrorse pale hairs to 1 mm long with scattered similar hairs on costules and veins; surfaces between veins bearing few to many appressed hairs 0.3–0.4 mm long, sometimes also glands which are never as abundant as on lower surface. Hairs on upper surface of *rachis* pale to brownish, curved, not over 1 mm long; on lower surface erect hairs as on costae. *Sori* medial, lower ones not divergent; *indusia* firm, usually with a few short hairs and glands; *sporangia* with glands near annulus.

Distr. Peninsular Thailand; Hainan, Hong Kong; throughout *Malesia*; North Queensland, Solomon Islands, New Hebrides, Fiji, Samoa.

Ecol. In forest, low country to 1500 m.

Notes. As here interpreted, this is a very variable species and varieties are not always sharply distinct; no formal names for them are here given. The following key attempts to distinguish the various forms.

#### KEY TO THE LOCAL FORMS

1. Lower pinnae lobed at least 2/3 towards costa and at least 1.5 cm wide.
2. Glands none or rare on upper surface of pinnae.
3. Fertile pinnae of large plants 2 cm wide (sterile ones sometimes wider); costules 4 mm apart, second acroscopic vein usually touching side of sinus-membrane . . . . . **typical form**
3. Fertile pinnae not over 1.5 cm wide; costules 3 mm apart; second acroscopic vein always to margin (*Dryopteris suprastrigosa* ROSENST.) . . . . . **New Guinea**
2. Glands  $\pm$  abundant on upper surface of pinnae.
4. Appressed hairs to 0.5 mm long between veins on upper surface . . . . . **Borneo**
4. Short suberect hairs between veins on upper surface . . . . . **Moluccas**
1. Lower pinnae lobed not or little more than 1/2 way to costa, rarely more than 1.5 cm wide.
5. Glands and appressed hairs (sometimes dense) on upper surface . . . . . **Borneo (limestone)**
5. Glands lacking on upper surface; appressed hairs variable, never dense.
6. Pinnae lobed distinctly more than 1/2; second acroscopic vein to margin.
7. Pinnae to 16  $\times$  1.6 cm; costules almost at right angles to costa; pinnae more than 20 pairs; sori supramedial . . . . . **Mindanao**
7. Pinnae to 10  $\times$  1.3 cm; costules at 60°; pinnae to 15 pairs; sori medial (*Nephrodium pubescens* BRACK., *Dryopteris bordenii* CHRIST) . . . . . **Luzon**
6. Pinnae lobed 1/2 or less deeply; second acroscopic vein usually ending beside sinus-membrane . . . . . **lowlands of W. Malesia**

The *typical form* occurs in mountain forest in Western Malesia and to Flores. In Malaya there seems to be no sharp distinction between the mountain form and the lowland one which comes at the end of the key. Plants like the lowland form of Malaya occur in Thailand, Hainan and Hong Kong, also in the lowlands of Borneo.

BLUME distinguished varieties *B* and *C* in *Java*. I have found no authentic specimen of the former; *var. C* has rather large almost sterile fronds with sori on basal veins only and is not a distinct variety.

The *Borneo* form with many glands and appressed hairs on the upper surface occurs in Sarawak and Sabah at low to medium altitudes.

The *limestone Bornean* form is abundant in the Gunong Mulu National Park; at higher altitudes and in more exposed positions fronds are smaller and very densely covered with hairs on the upper surface, but there seems to be no sharp distinction between these and plants with larger fronds less densely covered with hairs.

In the *Philippines* neither the typical form nor the lowland form of Western Malesia has been found. From Palawan is one collection somewhat resembling the Borneo form; from Mindanao are two specimens (RAMOS & PASCASIO BS 34476, Surigao Province, and EDANO PNH 12581, Davao Province) which seem distinct and are keyed as the Mindanao form, but a third (COPELAND 1643, San Ramon, 500 m) is nearer to the New Guinea form. In Luzon the form represented by *Dryopteris bordenii* (small, with short fronds) appears common; in herbaria it has been confused with the large specimens of *S. lobatus* (COPEL.) HOLTUM.

*Dryopteris suprastrigosa* appears to be the common form in eastern New Guinea; few collections have been made in the west. Specimens from North Queensland are similar but less hairy on the upper surface of pinnae. *D. mixta* was described from a small fertile plant with most veins free but does not appear distinct in other characters.

The *Moluccan* form is represented by BROOKS 18112 (Amboina) and KORNASSI 1222 (West Ceram).

BACKER & POSTHUMUS cite *Aspidium dimorphum* KUNZE as a synonym. This was based on a specimen of JUNGHUHN's from Mt Pangerango in W. Java; I have not found it. METTENIUS (l.c. 1864) described it briefly as a synonym of *A. heterocarpon var. B* BL. He stated that its aerophores were enlarged, for which reason I doubt whether it belongs here.

#### 25. *Sphaerostephanos isomorphus* HOLTUM, sp. nov.

*Stipes ignotus*; pinnae redactae 6-jugatae, omnes parvae; lamina 90 cm long; pinnae inferiores basi non angustatae; pinnae maximae 14.5  $\times$  2.0 cm, profunde lobatae; venae 12-jugatae, infimae anastomosantes; costae subtus pilis erectis minutis vestitae; pagina inter venas utrinque glandulosa; indusia parva, glandulifera.—Type: FLENLEY, ANU 2062, Papua New Guinea, W. Highlands, Lai valley (K).

*Caudex et stipe* not known. *Reduced pinnae* 6 pairs, 4 cm apart, all very small with enlarged aerophores; one intermediate pair of pinnae also present. *Lamina* 90 cm long; pinnae 40 pairs, light green when dry, firm; lower pinnae not narrowed at base. *Largest pinnae* 14.5  $\times$  2.0 cm, sterile and

fertile isomorphous; base truncate and slightly dilated; apex caudate-acuminate (cauda 2–2.5 cm), edges lobed to 2 mm from costa, lobes slightly falcate; costules 3–3.5 mm apart, at more than 60°; veins to 12 pairs, basal pair only anastomosing with excurrent vein to short sinus-membrane, next veins both to edge; lower surface of rachis, costae and costules bearing very short erect hairs and glands, between veins many glands but no hairs; hairs on upper surface of costae pale, less than 1 mm long, scattered hairs 0.5 mm long on costules and veins, glands between veins. *Sori* medial, lower ones divergent, those on basal veins from adjacent costules often touching; indusia very small, glandular; sporangia bearing glands.

Distr. *Malesia*: Papua New Guinea, only known from the type.

**26. *Sphaerostephanos dimidiolobatus* HOLTTUM, sp. nov.**

*Pinnae redactae usque 12-jugatae, superiores 2.5–3.0 cm longae; aerophori non elongati; pinnae normales usque 27 × 2.3 cm, dimidio costam versus lobatae; venae 8–10-jugatae, infimae solum anastomosantes; costae costulaeque subtus glanduliferae, glandulae inter venas paucae; pagina superior inter venas glandulis pilisque minutis praedita; indusia parva; sporangia glandulifera.* — Type: J.R. CROFT 324, New Ireland, 7 km WNW of Taron, 700 m (K; NSW).

*Stipe* 22–27 cm long, almost glabrous, slightly flushed with red, scales thin, c. 10 × 2 mm; base of stipe to first normal pinna 50–55 cm; reduced pinnae 8–12 pairs, uppermost 2.5–3.0 cm long, broadly triangular with subtruncate base slightly auricled both sides, edges crenate, lowest reduced pinna 1 cm long. *Lamina* excluding basal pinnae c. 100 cm long; basal pinnae slightly narrowed in basal third, basal lobes both slightly elongate; aerophores not elongate. *Largest pinnae* 20–27 cm long, to 2.3 cm wide; base truncate, not dilated nor auricled; apex narrowly acuminate, not caudate; edges lobed about half-way to costa (on one frond slightly more than half), lobes hardly falcate; costules 4.5–5 mm apart, at more than 60° to costa; veins 8–10 pairs, slender, slightly prominent when dry, basal pair at a broad angle to costule, anastomosing with an excurrent vein to the sinus, next pair usually both to sides of sinus-membrane; lower surface of rachis bearing very short hairs and some to 0.5 mm long, costae minutely hairy near base only, with glands throughout, few short hairs and many glands on costules, few glands between veins; upper surface of rachis and costae bearing hairs 0.5 mm long, minute hairs on costules and veins, between veins a variable number of glands and very short erect hairs. *Sori* medial; indusia small, shrivelled, with a few short hairs and (?) glands; glands present on body of some sporangia, more commonly sessile on stalks of sporangia; spores not seen (*sori* old).

Distr. *Malesia*: Papua New Guinea (S. New Ireland), 2 collections.

Ecol. In forest at 650–700 m.

**27. *Sphaerostephanos solutus* HOLTTUM, sp. nov.**  
— *Aspidium hispidulum* DECNE var. *solutum* MIQUEL, Ann. Mus. Bot. Lugd.-Bat. 4 (1868) 160. — *Aspidium hispidulum* var.  $\beta$  METT. *ibid.* 1 (1864) 234. — Type: SPANOGHE (?), Timor (L, n. 908, 333–406).

Base of frond lacking. *Lamina* of specimen 55 cm long with 20 pairs pinnae. *Largest pinnae* 19 × 2.1 cm, base truncate with acroscopic lobe of many pinnae elongate, apex caudate-acuminate, edges lobed to 2.5 mm from costa, lobes falcate; costules 4–4.5 mm apart, at 60°; veins 12 pairs, 1–1½ pairs anastomosing, one vein or a pair to sinus-membrane; hairs on lower surface of costae and rachis sparse, erect, 0.3 mm long, similar but shorter and more sparse on costules, glands also present; between veins glands and sparse short erect hairs; hairs on upper surface of costae 0.3 mm long, similar hairs scattered on costules and veins, very short erect hairs and glands between veins. *Sori* medial, lower ones not divergent; indusia thin, with a few glands and short hairs; sporangia with glands on body.

Distr. *Malesia*: Lesser Sunda Is. (Timor), only known from the type.

Note. The type bears the name *Aspidium solutum* n. sp. in BLUME's hand, also *Aspidium hispidulum* var.  $\beta$  METT. and is evidently the one referred to by METTENIUS and MIQUEL, but they give ZIPPELIUS as collector whereas the specimen here cited bears the collector's name SPANOGHE. *A. hispidulum* DECNE (P) = *Christella hispidula*.

**28. *Sphaerostephanos hernaезii* HOLTTUM, sp. nov.**

*Caudex suberectus; stipes 10–15 cm longus; pinnae redactae c. 6-jugatae, superiores 5–6 mm longae; lamina 45 cm longa; pinnae 9-jugatae, inferiores usque 11.5 × 2.5 cm, basin versus sensim angustatae, dimidio costam versus lobatae; costulae 7 mm inter se distantes; venae 9-jugatae; pagina utrinque pilis erectis brevibus glandulisque praedita; sori mediales, indusia pilis brevibus vestita.* — Type: M. G. PRICE & B. E. HERNAEZ 75, Western Samar (K).

*Caudex* suberect. *Stipe* 10–15 cm long, glabrous apart from short hairs in groove; basal scales 8 × 1 mm, copiously setiferous; base of stipe to first large pinna 45 cm. *Reduced pinnae* c. 6 pairs, uppermost 5–6 mm long, lowest 2 mm. *Lamina* to 45 cm long; pinnae to 9 pairs, widely spaced, basal ones longest; apical lamina almost pinna-like but with widened base; aerophores not elongate. *Basal pinnae* to 11.5 × 2.5 cm, widest 1/3 from apex and gradually narrowed to narrowly cuneate base, in middle lobed half way to costa, apex

short-acuminate; lobes slightly falcate, tapered from base to an obtuse tip; costules to 7 mm apart; veins to 9 pairs,  $1\frac{1}{2}$  pairs anastomosing, one vein or a pair to short sinus-membrane; hairs on lower surface of rachis and costae 0.2–0.3 mm long, antrorsely curved, shorter hairs on costules and veins, between veins minute erect hairs and copious glands; hairs on upper surface of rachis and costae to 0.5 mm, rest as lower surface. Upper pinnae gradually less narrowed at base but uppermost somewhat narrowed. Sori medial, basal ones a little divergent and a little elongate along veins; indusium with copious short hairs and some glands; no glands nor hairs on sporangia.

Distr. *Malesia*: Philippines (Samar), only known from the type.

Ecol. In primary forest on limestone and limestone-derived soil.

Note. Young plants have fewer and short pinnae but almost equally wide, with few lobes and widely-spaced costules.

**29. *Sphaerostephanos moseleyi* HOLTUM, sp. nov.**

*S. pennigero affinis, ab eo differt: fronde minore; pinnis redactis 3–5-jugatis, omnibus parvis; pinnis normalibus 7–12-jugatis, fertilibus usque 15 × 2.1 cm; venis 2½-jugatis anastomosantibus; sporangiis nec setiferis nec glanduliferis.* — Type: MOSELEY s.n. Challenger Exp., Aru Islands (K; BM).

Caudex short-creeping; stipe 20–35 cm long, basal scales 7 × 1 mm; base of stipe to first normal pinna 35–65 cm; reduced pinnae 3–5 pairs, lowest very small, uppermost c. 5 mm long. Lamina to 50 cm long; pinnae 7–12 pairs. Largest fertile pinnae 15 × 2.1 cm, shaped as in *S. penniger* but with costules at a very wide angle to costa; veins 8 pairs,  $2\frac{1}{2}$  pairs anastomosing, 1 pair to sinus-membrane; pubescence as in *S. penniger* but some short erect hairs in addition to glands between veins on both surfaces. Sori medial, lower ones divergent, those on basal veins from adjacent costules sometimes confluent; indusia copiously glandular; sporangia lacking glands or hairs distally, glands at ends of hairs on sporangium-stalks conspicuous.

Distr. *Malesia*: S.E. Moluccas (Aru Is.).

Notes. In addition to the type are BUWALDA 4984 and 5169, both from Kbroör I., the former much like the type. Number 5169 (from forest in steep rocky limestone country) is sterile, with longer fronds than the type and pinnae to 24 × 2.7 cm, with 13–14 pairs of veins but only  $2\frac{1}{2}$  pairs anastomosing, 2 or 3 pairs passing to a long sinus-membrane.

**30. *Sphaerostephanos productus* (KAULF.) HOLTUM, Kalikasan 4 (1975) 59.** — *Aspidium productum* KAULF. Enum. Fil. Chamisso (1824) 237; METT. Farngett. IV (1858) 109. — *Dryopteris*

*producta* (KAULF.) C. CHR. Ind. Fil (1905) 286; v.A.v.R. Handb. (1908) 230. — *Cyclosorus productus* (KAULF.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 248; COPEL. Fern Fl. Philip. (1960) 348, *nomen tantum*. — *Thelypteris producta* (KAULF.) REED, Phytologia 17 (1968) 306. — Type: CHAMISSO, Manila (LE).

*Nephrodium philippinense* BAK. Ann. Bot. 5 (1891) 327. — *Dryopteris basilaris* C. CHR. Ind. Fil. (1905) 254, *nom. nov. superfl.*; CHRIST, Philip. J. Sci. 2 (1907) Bot. 186; v.A.v.R. Handb. (1908) 820. — *Dryopteris philippinensis* (BAK.) COPEL. Philip. J. Sci. 56 (1935) 100. — Lectotype (HOLTUM 1975): CUMING 10, Luzon (K).

*Dryopteris luzonica* var. *puberula* CHRIST, Philip. J. Sci. 2 (1907) Bot. 197. — Type: BOLSTER 175, Luzon (P).

*Dryopteris kotoensis* HAYATA, Ic. Pl. Formosa 5 (1915) 279, f. 107. — *Cyclosorus truncatus* var. *kotoensis* H. ITO, Bot. Mag. Tokyo 51 (1937) 729. — *Thelypteris kotoensis* (HAYATA) K. IWATS. Acta Phytotax. Geobot. 21 (1964) 42; Mem. Coll. Sci. Univ. Kyoto B, 31 (1965) 189. — *S. kotoensis* (HAYATA) HOLTUM in C. M. Kuo, Fl. Taiwan 1 (1975) 436. — Type: KAWAKAMI & SASAKI s.n. July 1912, Taiwan, Kotosho I. (TI; seen by IWATSUKI).

*Dryopteris pseudohirsuta* ROSENST. Meded. Rijksherb. n. 31 (1917) 7. — *Thelypteris pseudohirsuta* (ROSENST.) REED, Phytologia 17 (1968) 306. — Type: CUMING 82, *partim* (L).

*Cyclosorus serratus* COPEL. Philip. J. Sci. 81 (1952) 36; Fern Fl. Philip. (1960) 365. — Type: COPELAND P. P. E. 19, Luzon, Lamao River (MICH; K).

*Cyclosorus weberi* COPEL. Philip. J. Sci. 81 (1952) 36, t. 25; Fern Fl. Philip. (1960) 366. — *Thelypteris weberi* (COPEL.) REED, Phytologia 17 (1968) 324. — Type: WEBER 1174, Mindanao (US; K).

*Cyclosorus rigidus* COPEL. Philip. J. Sci. 81 (1952) 27; Fern Fl. Philip. (1960) 340, not *C. rigidus* (RIDL.) COPEL. 1951. — *Thelypteris ugoensis* REED, Phytologia 17 (1968) 322, *nom. nov.* — Type: RAMOS BS 5744, Luzon, Mt Ugo (MICH).

*Cyclosorus leucadenius* COPEL. Philip. J. Sci. 81 (1952) 27; Fern Fl. Philip. (1960) 339. — *Thelypteris leucadenia* (COPEL.) REED, Phytologia 17 (1968) 287. — Type: ELMER 8999, Luzon, Baguio (MICH; K, E, L, BO).

*S. punctatus* HOLTUM, Kalikasan 4 (1975) 60. — Type: ELMER 16642, Luzon, Mt Bulusan (US; K, L, G, BO, NSW).

*Cyclosorus megaphyllus* sensu COPEL. Fern Fl. Philip. (1960) 367.

*Cyclosorus nitidulus* sensu COPEL. Fern Fl. Philip. (1960) 364, p.p.

Caudex short-creeping, branched. Size of fronds very variable, with pinnae from 10 × 1 to 30 × 2.7 cm. Stipe short; basal scales 10–20 mm long, narrow. Reduced pinnae 6–12 pairs, not



deflexed, broadly ovate to bluntly triangular, subentire, uppermost commonly 1–1.5 cm long and wide, lowest 0.5 cm. *Normal pinnae* crenate in smallest fronds, commonly lobed almost 1/3, in largest fronds 1/2 towards costa; costules always at about 45° to costa except in largest fronds: veins 4–11 pairs, in almost all cases 1½ pairs anastomosing and 1 pair to sinus-membrane; hairs on lower surface of costae near base very short (rarely with some more than 0.5 mm long), to 0.2 mm or more long distally, very short and sparse on costules and veins, many glands and few hairs between veins; hairs on upper surface of costae to 0.5 mm long, on costules and veins all very short, glands between veins abundant. Hairs on lower surface of *rachis* variable, 0.2–0.5 mm or more long, on upper surface to 1 mm long. *Sori* medial, lower ones not or little divergent; indusia firm, bearing glands and sometimes a few short hairs; sporangia bearing 1–2 setae or glands on body and a spherical gland at end of hair on stalk; spores with many small wings.

Distr. *Malesia*: Philippines (Luzon to Mindanao); Taiwan (Orchid Island only).

Ecol. In forest at low and medium altitudes.

Notes. In 1975 I distinguished *S. punctatus*, with large pinnae lobed fully half-way to costa and costules at a rather broad angle, but these do not appear to be sharply distinct; such specimens occur also on Orchid Island (S.E. of Taiwan) along with others indistinguishable from the type of *Nephrodium philippinense* BAK. The specimen originally described by KAULFUSS has pinnae 9×0.9 cm; the type of *Cyclosorus serratus* COPEL. 10×0.8 cm, the type of *Nephrodium philippinense* 18×1.4 cm; some other types come between these extremes.

The name *Nephrodium basilare* PRESL (Epim. Bot. 258) was published as a substitute for *N. caudiculatum* J. SM. non PRESL (Hook. J. Bot. 3:411), but SMITH's name was a *nomen nudum*, and the first valid name based on the specimens cited by SMITH was *N. philippinense* BAK. When transferring this to *Dryopteris*, CHRISTENSEN (1905) preferred the epithet *basilaris* because of the existence of *Phegopteris philippinensis* METT.

METTENIUS evidently did not see the CHAMISSE specimen (he cited CUMING LI, which I cannot trace), but he gave a fairly good description, mentioning the glands on the lower surface which no other author noticed. HOOKER and BAKER made no reference to *Aspidium productum* KAULF. CHRISTENSEN, CHING, COPELAND and REED transferred the species to other genera without describing it. When describing *Dryopteris producta*, VAN ALDERWERELT referred to METTENIUS, but did not copy METTENIUS's description; he gave a better description under *D. basilaris*. COPELAND misconstrued the species in his Fern Flora of the Philippines, placing it as a synonym of *Nephrodium nitidulum*

PRESL, which belongs to the genus *Pneumatopteris*.

**31. *Sphaerostephanos penniger* (HOOK.) HOLT-TUM** in Nayar & Kaur, Comp. to Bedd. (1974) 209. — *Aspidium pennigerum sensu* BL. Enum. Pl. Jav. (1828) 153. — *Nephrodium pennigerum* HOOK. Spec. Fil. 4 (1862) 82, nom. nov.; RACIB. Fl. Btzig 1 (1898) 190. — Type: BLUME, Java, Boerangrang (L).

*Aspidium megaphyllum* METT. Ann. Mus. Bot. Lugd.-Bat. 1 (1864) 233; MIQUEL, *ibid.* 4 (1869) 159. — *Dryopteris megaphylla* (METT.) C. CHR. Ind. Fil. (1905) 277; v.A.v.R. Handb. (1908) 218; BACKER & POSTH. Varenfl. Java (1939) 50. — *Cyclosorus megaphyllus* (METT.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 8 (1938) 225; HOLT-TUM, Rev. Fl. Mal. 2 (1955) 268, f. 154. — *Thelypteris megaphylla* (METT.) K. IWATS. Mem. Coll. Sci. Univ. Kyoto B. 31 (1964) 34. — Type: METTENIUS cited REINWARDT and ZIPPILIUS, Java (L).

*Aspidium multilineatum* WALL., nom. nud. — *Nephrodium pennigerum var. multilineatum* CLARKE, Trans. Linn. Soc. Bot. 1 (1880) 532. — *Nephrodium multilineatum* BEDD. Handb. Suppl. (1892) 80 (not *Aspidium multilineatum* METT. 1858). — *Dryopteris multilineata* (BEDD.) O. KTZE, Rev. Gen. Pl. 2 (1891) 811; v.A.v.R. Handb. (1908) 219. — Type: WALLICH 353, Penang (K).

*Aspidium abortivum sensu* METT. Farngatt. IV (1858) 110, *quoad* ZOLLINGER 3525 *tantum*.

*Nephrodium abruptum sensu* HOOK. Spec. Fil. 4 (1862) 78, p.p., t. 241 B. — Fig. 1a–h.

#### KEY TO THE VARIETIES

1. Lower pinnae not over 4 cm wide, lobed not more than 1/3 towards costae.
2. Normal pinnae to 25 pairs, reduced pinnae 10–15 pairs . . . . . a. var. *penniger*
2. Normal pinnae 7 pairs; reduced pinnae 5 pairs . . . . . c. var. *karoensis*
1. Lower pinnae to 7 cm wide, lobed to 3 mm from costa . . . . . b. var. *excellens*

#### a. var. *penniger*

*Caudex* short-creeping. *Stipe* 8–10 cm long; scales to 10×1 mm, closely setiferous; base of stipe to first large plant 80 cm. *Reduced pinnae* 10–15 pairs, upper ones to 3×2 cm, spreading, triangular with a not quite truncate symmetric base, blunt apex and subentire edges, lowest on a large plant 1×1 cm. *Lamina* to 100 cm long; pinnae 25 pairs; basal pinnae not or slightly narrowed at base; apex not pinna-like; aerophores slightly swollen. *Largest pinnae* commonly 20×2.8 cm (to 30×4 cm), lobed to a depth of 3–5 mm, lobes oblique, subdeltoid, broadly pointed; costules 5.5–7 mm apart, at 60°; veins 8–12 pairs, 3–3½ pairs anastomosing to form a zig-zag excurrent vein,

1–2 pairs to sinus-membrane; hairs on lower surface of rachis and base of costae very short, distally on costa and costules 0.2–0.3 mm, somewhat antrorse, between veins many glands; hairs on upper surface of costae 0.5 mm long, minute on costules, many glands between veins. *Sori* medial, lower ones not divergent; indusia glandular with a few short acicular hairs; sporangia with short setae and glands on body, hair on stalk often with a conspicuous terminal gland.

Distr. Peninsular Thailand, in *Malesia*: Malaya, Sumatra, Borneo, Java, Lesser Sunda Is. (Bali, Lombok), S.W. and N. Celebes.

Notes. On p. 78 of *Species Filicum* vol. 4 (which was printed off in fascicles of 16 pages) HOOKER cited his specimens of this species under *Nephrodium abruptum* and with them specimens belonging to six other species; his plate 241B certainly represents a specimen of *S. penniger*. In the next fascicle, on p. 82, he revised his opinion and cited all his specimens of the present species under *N. pennigerum*, based on *Aspidium pennigerum* BL. stating correctly that they agreed with a specimen so named by BLUME. HOOKER's description is a translation of BLUME's; his name, in *Nephrodium*, ranks as a new name.

BLUME's name was based on a misinterpretation of *Polypodium pennigerum* FORST. which represents a New Zealand species very different from the Java one, and in citing BLUME HOOKER excluded the FORSTER name; in his fifth volume HOOKER retained *Polypodium pennigerum* FORST. for the New Zealand fern, which is exindusiate.

HOOKER's confusions on p. 78 misled BEDDOME, who united an Indian species with the Malesian *S. penniger* under the name *Nephrodium abruptum* in Ferns of S. India, and then under *N. pennigerum* (Handb. p. 277). In the Supplement to his Handbook BEDDOME separated the two, adopting WALLICH's name *multineatum* for the Malesian species; this in turn led to confusions in the name of another Indian species.

**b. var. *excellens*** (BL.) HOLTUM, *stat. nov.* — *Aspidium excellens* BL. Enum. Pl. Jav. (1828) 160; C. CHR. Ind. Fil. (1905) 73. — *Proferea excellens* (BL.) PRESL, Epim. Bot. (1851) 259; HOLTUM, Novit. Bot. Univ. Carol. Prag. 1968 (1969) 48. — *Pleocnemia excellens* (BL.) v.A.v.R. Handb. (1908) 171. — *Tectaria excellens* C. CHR. Ind. Fil. Suppl. III (1834) 179. — Type: BLUME, Java (PRC; L, K).

Upper part of frond indistinguishable from the typical form of *S. penniger*; lower pinnae greatly enlarged, lowest 30×7 cm, lobed to 3 mm from costa, costules 9 mm apart, lobes falcate and tapered to an acute tip, venation in lobes pleocnemoid, in largest lobes aerioles of more than one series along costule.

Distr. *Malesia*: Java, only one collection.

Note. In the Rijksherbarium at Leiden are two sheets, one bearing the apical part of a frond, the other a lower part of the same frond, but not the base. The base of the frond appears to have been divided between HOOKER (one pair of pinnae) and PRESL who had the three lowest pairs of large pinnae and two pairs of reduced pinnae.

**c. var. *karoensis*** HOLTUM, *var. nov.*

A *typo speciei differt: fronde minore; pinnis redactis 5-jugatis; pinnis evolutis 7-jugatis, usque 13×2.7 cm, infimis basin versus valde angustatis; sporangiis setiferis, non glanduliferis.* — Type: MOLESWORTH ALLEN 2407, Sumatra, Prapat by Lake Toba (K).

Distr. *Malesia*: N. Sumatra, only known from the type.

**32. *Sphaerostephanos warburgii*** (KUHN & CHRIST) HOLTUM, Allertonia 1 (1977) 202. — *Aspidium warburgii* KUHN & CHRIST in Warburg, Monsunia 1 (1900) 81. — *Dryopteris warburgii* (KUHN & CHRIST) C. CHR. Ind. Fil. (1905) 98; v.A.v.R. Handb. (1908) 180. — *Cyclosorus warburgii* (KUHN & CHRIST) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 250; COPEL, Philip. J. Sci. 78 (1951) 441. — *Thelypteris warburgii* (KUHN & CHRIST) B. C. STONE, Micronesica 2 (1966) 3. — Type: WARBURG, N.E. New Guinea, Sattelberg (B).

*Dryopteris calcicola* C. CHR. Bot. Jahrb. 66 (1933) 44. — Type: KJELLBERG 2611, S.E. Celebes, Kosali-Porema (S-PA; BM).

*Caudex* short, erect. *Stipe* 1–3 cm long. *Lamina* 10–15 cm long; pinnae to 18 pairs, several lower pairs gradually smaller, lowest 3–5 mm long. *Largest pinnae* 1.5–1.8 cm long, 0.3–0.4 cm wide, distinctly stalked, base unequally cuneate, edges entire or rarely crenulate, apex rounded or obtusely pointed; costules 1.5 mm apart, at 45°, distal ones unbranched, rest forked once or twice, branches of neighbouring ones anastomosing; lower surface of costae bearing short hairs, sometimes with scattered long ones, glands throughout between veins; upper surface glabrous apart from costae and costules, not glandular. Hairs on rachis to 1 mm long, both sides. *Sori* uniseriate on each side of the costa; indusia with a few short hairs; sporangia bearing glands, on specimens from Tenimbar Islands and Celebes also setae.

Distr. Micronesia (Guam, Admiralty Is.), and *Malesia*: New Guinea, S.E. Moluccas (Tenimbar Is.), and Central & S.E. Celebes.

Note. Specimens from Guam only differ from those of New Guinea by their larger size (frond to 30 cm long, pinnae to 3 cm long), agreeing in glandular sporangia. The type of *D. calcicola*, from limestone, differs in fewer glands on lower surface of pinnae, densely hairy indusia and setose sporangia.

Ecol. On rocky stream banks.

**33. *Sphaerostephanos tandikatis* (v.v.R.) HOLTUM, comb. nov.** — *Dryopteris tandikatis* v.v.R. Bull. Jard. Bot. Btzig II, 11 (1913) 11; Handb. Suppl. (1917) 178, 503. — Type: MATTHEW 635, Sumatra, G. Tandikat (BO).

*Caudex* short-creeping. *Stipe* 4–5 cm long, short-hairy; basal scales 3–4 × 1 mm; base of stipe to first large pinna 35–45 cm. *Reduced pinnae* 12–15 pairs, broadly ovate, uppermost 10 × 8 mm with a small auricle on acroscopic base, lowest 3–4 mm long. *Lamina* to 45 cm long; pinnae 3–4 pairs, lowest pinna usually a little reduced; apex of lamina pinna-like, larger than pinnae on fronds of young plants; aerophores slightly swollen. *Pinnae* of type to 11 × 4 cm, of another specimen to 17 × 6.5 cm, widest at or above middle, base abruptly broad-cuneate, of lower ones asymmetric; apex abruptly short-cuspidate; edges entire, or crenate distally; costules 3.5–4.5 mm apart, at 60° or rather less; veins 12–14 pairs, almost all anastomosing, combined excurrent veins almost straight, mostly continuous; lower surface of costae and costules densely covered with erect hairs 0.1 mm long, veins and surface less densely, glands present on veins and surface between them; upper surface covered with appressed hairs 0.3 mm long, no longer hairs present. Hairs on both sides of rachis also short. *Sori* all supramedial, those on veins from adjacent costules often coalescing; indusia small, short-hairy; sporangia with many setae.

*Distr. Malesia:* South and Central Sumatra, 720–1400 m, several collections.

**34. *Sphaerostephanos carrii* HOLTUM, sp. nov.**

*Pinnae redactae* 4-jugatae, superiores 1.5 cm longae; lamina usque 45 cm longa; pinnae 6–7-jugatae, omnes oppositae, 10 × 2.7 cm vel majores, vix usque 1/3 costam versus lobatae; lamina inter venas subtus glandulosa, supra glabra eglandulosa; indusia tenuia, pilis brevibus glandulisque praedita; sporangia setifera. — Type: C. E. CARR 14202, Papua, Boridi, 1500 m (K; BM, L, LAE).

*Caudex* short-creeping or suberect. *Stipe* 12–20 cm long; basal scales 7–10 × 1.5–2 mm, thin, setiferous; base of stipe to first large pinna 40–50 cm. *Reduced pinnae* 4–5 pairs, lowest 4 mm long, uppermost 1.5 cm, deflexed and auricled. *Lamina* 30–45 cm long; pinnae 6–7 pairs, opposite; lowest pinnae narrowed in basal 1/3 on basiscopic side, truncate but not auricled on acroscopic side; apical lamina almost pinna-like but larger and more deeply lobed at base; texture thin; aerophores not elongate. *Suprabasal pinnae* 10–17 × 2.7–3.5 cm, base truncate, apex abruptly short-acuminate, edges lobed rather less than 1/3 to costa, lobes slightly falcate with rounded tips; costules 5–6 mm apart; veins 10–12 pairs, 2½ pairs anastomosing, 1–1½ pairs passing to sinus membrane; lower surface of costae and costules bearing short spreading hairs, distally on costa to 0.5 mm long, short erect hairs and sparse glands

between veins; hairs of upper surface of costae mixed in length, longest 1 mm or more, scattered similar long hairs on costules and veins, surface between veins glabrous. Hairs on lower surface of rachis rather sparse, 1–1.5 mm long, on upper surface copious, mostly 0.5 mm, longest 1–1.5 mm. *Sori* medial, basal ones not divergent; indusia bearing short hairs and a few glands; sporangia setiferous.

*Distr. Malesia:* Eastern New Guinea, 3 collections.

**35. *Sphaerostephanos exindusiatus* HOLTUM, sp. nov.**

*Pinnae redactae* 15-jugatae, superiores vix 10 mm longae; lamina 60 cm longa; aerophora 2 mm longa; pinnae maximae 12 × 1.5 cm, 3/5 costam versus lobatae; venae 8-jugatae; costa subtus pilis erectis 0.5 mm longis praedita, lamina inter venas glandulosa; pagina superior omnino pilis appressis vestita; sori exindusiati, sporangia setifera. — Type: POSTHUMUS 3494, S.W. Celebes, near Patapang, 1200 m, on river bank (BO).

*Caudex* short, thick, suberect. *Stipe* 15–20 cm long, densely scaly throughout when young; scales to 10 × 2 mm, thin; base of stipe to first large pinna 50 cm. *Reduced pinnae* at least 15 pairs, 1.5–2 cm apart, lowest 4 mm long, uppermost hardly 10 mm. *Lamina* 60 cm long; pinnae 25 pairs or more; lower pinnae not or little narrowed at base; aerophores 2 mm long. *Largest pinnae* 12 × 1.5 cm, base truncate and a little dilated both sides, apex narrowly acuminate, edges lobed about 3/5 to costa, lobes slightly falcate; costules 3–3.5 mm apart; veins to 8 pairs, 1 pair anastomosing, next acroscopic vein to side of sinus-membrane; lower surface of costae and costules bearing rather sparse erect hairs 0.5 mm long, surface between veins copiously glandular; hairs on upper surface of rachis and costae 1 mm long, scattered similar hairs on costules and veins, whole surface covered with slender appressed hairs. *Sori* inframedial, exindusiati; young sporangia bearing several short setae.

*Distr. Malesia:* S.W. Celebes, only known from the type.

**36. *Sphaerostephanos lucbanii* HOLTUM, sp. nov.**

*Pinnae redactae* 2-jugatae; lamina 25 cm longa; pinnae liberae 7-jugatae, tenues, maximae 6 × 1.8 cm, 1/3–2/5 costam versus lobatae; venae 5–6-jugatae; costae subtus pilis usque 1 mm longis vestitae, pagina inter venas pilis erectis glandulisque praedita; pagina superior pilis appressis vestita; sori exindusiati; sporangia setifera. —

Type: M. G. PRICE 2720A, Luzon, Mt Bana-haw, streamside at 1000 m (K).

*Caudex* slender, short-creeping. *Stipe* 5 cm long, densely short-hairy, scales 3 mm long; base of stipe to first large pinna 11 cm. *Reduced pinnae*

2 pairs on largest frond, lower ones  $6 \times 3$  mm, upper one deflexed,  $10 \times 6$  mm, crenate, base asymmetric. *Lamina* 25 cm long, thin, apex narrowly triangular, 13 cm long, deeply lobed and grading to upper pinnae, venation in its basal lobes as in *Haplodictyum*; free pinnae 7 pairs, lowest distinctly stalked, somewhat narrowed at base on basiscopic side, aerophores swollen. *Largest pinnae*  $6 \times 1.8$  cm, base truncate, apex shortly pointed, edges lobed  $1/3$ – $2/5$  to costa, lobes rounded, entire; costules 4.5 mm apart, at  $60^\circ$ ; veins 5–6 pairs, 1 pair anastomosing with long excurrent vein, next acroscopic vein to short sinus-membrane; hairs on lower surface of costae rather sparse, pale, slender, 0.5–1 mm long, on costules same but few, between veins slender erect hairs 0.2 mm long and glands; hairs on upper surface of costae 0.5 mm long, rest of upper surface covered with slender appressed hairs 0.2–0.3 mm long. Hairs on both sides of *rachis* slender, to 1.5 mm long. *Sori* medial, exindusiate; sporangia setiferous.

Distr. *Malesia*: Philippines (Luzon), only known from the type.

Note. Under the same number and near the same locality Mr PRICE also collected very much smaller plants with lamina to 7 cm long, pinnae 2 pairs, 1 cm long, subentire, but fully fertile. These small plants (separated as *n.* 2720B) agree in sori and in pubescence with the larger ones above described. They agree also closely in all respects with *Dryopteris diminuta* COPEL. from Mindanao, which I have transferred to *Pronephrium*. Mr PRICE calls my attention to the plants described by COPELAND as *Dryopteris bakeri* in Philip. J. Sci. 38 (1929) 135; one of them had much larger pinnae than the rest. It is thus possible that the whole collection 2720 represents different stages of plants on one species.

**37. *Sphaerostephanos major* (COPEL.) HOLTUM, comb. nov.**—*Haplodictyum majus* COPEL. in Elmer, Leaflet. Philip. Bot. 9 (1920) 3110; Fern Fl. Philip. (1960) 378; HOLTUM, Kalikasan 2 (1973) 61.—Type: RAMOS BS 13992, Luzon, Mountain Prov., Apayao (MICH).

*Cyclosorus dimorphus* COPEL. Philip. J. Sci. 83 (1954) 99, pl. 5, non (BRAUSE) COPEL. 1960.—Type: EDAÑO PNH 17282, Luzon, Mountain Prov., Mt Magnas (MICH).

? *Dryopteris bakeri sensu* COPEL. Philip. J. Sci. 38 (1929) 135.

*Caudex* short-creeping; *fronds* dimorphous. *Sterile frond*. *Stipe* to 4 cm long; base of stipe to first large pinna 6–12 cm; *reduced pinnae* 1–2 pairs, very small; *apical lamina* 12–20 cm long, deeply lobed, 2.5–4 cm wide at base, veins in lobes mostly forked, the branches uniting to form a series of costular areoles, base of lamina grading into 2–4 pairs of pinnae closely placed; *pinnae* on largest frond  $3.5 \times 2$  cm, broadly pointed, lobed to

about  $1/3$ , with long spreading hairs on lower surface of costae, short erect hairs and glands between veins, upper surface covered with short appressed hairs. *Fertile frond*. *Stipe* 13 cm or more, base of stipe to first large pinna 20–27 cm; *reduced pinnae* as sterile but more widely spaced; *apical lamina* to  $12 \times 2$  cm, veins mostly not forked; *pinnae* to  $2.5 \times 1.4$  cm, more widely spaced and less deeply lobed than sterile; *sori* on both apical lamina and pinnae, basal ones sometimes a little elongate; indusium small with many hairs; sporangia with 2–3 long setae and sometimes also a gland.

Distr. *Malesia*: Philippines (mountains of northern Luzon).

**38. *Sphaerostephanos polyotis* (C. CHR.) HOLTUM, comb. nov.**—*Dryopteris polyotis* C. CHR. Bot. Jahrb. 66 (1933) 46.—*Thelypteris polyotis* (C. CHR.) REED, Phytologia 17 (1968) 305.—Type: KJELLBERG 1718, S.W. Celebes, Todjamboe, below 1000 m (BO; BM).

*Caudex* short, suberect. *Stipe* 5–10 cm long; base of stipe to first normal pinna 35–70 cm. *Reduced pinnae* 25–30 pairs, 1 cm apart on type (to 2.5 cm on other specimens), lowest 4–5 mm long, uppermost 1.5–2.0 cm long, deflexed with basal acroscopic lobe 7 mm long, basiscopic lobe shorter, edges incised, apex obtuse or rounded. *Lamina* of type 75 cm long; normal pinnae 25 pairs, basal ones a little narrowed towards their bases, with enlarged basal lobes; aerophores not elongate. Lower surface of *rachis* densely short-hairy, hairs to 0.5 mm long; upper surface with antrorse pale hairs. *Largest pinnae* of type  $7 \times 1.0$  cm (of WALKER 12187  $14 \times 2.0$  cm); base truncate; apex acuminate; edges lobed  $1/2$ – $2/3$  towards costa; costules 3–3.5 mm apart, at  $60^\circ$  to costa; veins of type to 5 pairs, of WALKER 12187 10–12 pairs, in both cases 1 pair anastomosing and next acroscopic vein ending beside sinus-membrane; lower surface of costae densely covered with erect hairs of mixed length to 0.5 mm, more sparse hairs and sometimes glands on costules (not seen on type), surface between veins of WALKER 12187 bearing short erect hairs and a few glands; upper surface  $\pm$  closely covered with short appressed hairs. *Sori* medial; indusia bearing short hairs and sometimes a few glands; sporangia bearing glands and sometimes setae.

Distr. *Malesia*: S.W. Central Celebes (Lati-modjong Mts).

Notes. Additional collections are T. G. WALKER 12186–12188, 12270, 12273, 12282 (BM). Most of these are larger than the type, but 12188 has normal pinnae of the same size as the type with fewer reduced pinnae. WALKER's specimens also have some glands on the lower surface of costules and between veins, but setae more abundant than glands on sporangia. This species and *S. foliolosus* are related to *S. hispiduliformis*

of New Guinea, but the transition from normal to reduced pinnae at the base of fronds of the latter is not abrupt.

**39. *Sphaerostephanos grandescens* HOLTUM, sp. nov.**

*Pinnae redactae* c. 6-jugatae, omnes parvae; lamina 45 cm longa; pinnae 12-jugatae, 2/3 vel ultra costam versus lobatae; costulae 5 mm inter se distantes; pagina subtus inter venas sparsim glandulifera, supra omnino pilis appressis vestita; indusia pilis brevibus paucis praedita, sporangia setifera. — Type: MERRILL 6094, Mindoro, Mt Halcon (MICH).

*Stipe* 7–14 cm long, glabrescent; base of stipe to first large pinna 45 cm or more. *Reduced pinnae* 6 pairs, 3rd from base 3–4 mm long, upper ones apparently not much larger. *Lamina* 45 cm long; pinnae 12–13 pairs, basal pair widest above middle, narrowed to base which is 1.2 cm wide, not auricled; aerophores elongate, less than 1 mm long. *Largest pinnae* 12.5 × 2.4 cm, base broadly cuneate, apex acuminate, edges lobed to 3.5 mm from costa (more than 2/3), lobes oblique, slightly falcate, a little narrowed distally; costules 5 mm apart, at less than 60°; veins to 9 pairs, 1 pair anastomosing, next acroscopic vein usually to side of sinus-membrane; hairs on *lower surface* of costae less than 0.5 mm long, antrorse distally, on costules same but sparse, sparse glands on costules and on surface between veins; hairs on *upper surface* of costae 0.6 mm, scattered similar hairs on costules and veins, whole surface covered with slender hairs 0.3–0.4 mm long. Hairs on lower surface of *rachis* pale, curved, spreading, 0.6 mm long, on upper surface similar but appressed. *Sori* medial, lower ones not divergent; indusia rather firm, with a few short hairs only; sporangia setiferous.

*Distr. Malesia:* Philippines (Mindoro: Mt Halcon).

*Note.* This specimen was named *Dryopteris bordenii* (here placed as a variety of *S. heterocarpus*) by CHRIST, but has much wider pinnae and setiferous sporangia and elongate aerophores; it is near *S. magnus*, but smaller.

**40. *Sphaerostephanos magnus* (COPEL.) HOLTUM, comb. nov. — *Cyclosorus magnus* COPEL. Philip. J. Sci. 81 (1952) 30; Fern Fl. Philip. (1960) 346. — *Thelypteris magnus* (COPEL.) REED, Phytologia 17 (1968) 291. — Type: MERRILL 6952, Negros (MICH; B, P).**

*Stipe* 10 cm, glabrescent; scales broadly ovate, thin, 2.5 mm wide; base of stipe to first normal pinna to 85 cm. *Reduced pinnae* many pairs, each consisting of an aerophore more than 1 mm long and a minute green blade. *Lamina* to 100 cm long; pinnae c. 30 pairs; basal pinnae apparently not narrowed at their bases. *Largest pinnae* 21 × 2.5 cm, base subtruncate, apex acuminate, edges

lobed 3/5 to costa, lobes falcate, somewhat narrowed distally; costules 5 mm apart, at more than 60°; veins to 9 pairs, basal pair anastomosing, next pair to sides of sinus-membrane; hairs on *lower surface* of rachis sparse, to 1 mm long, on costae and costules very short throughout with much longer ones also distally; many glands throughout lower surface; *upper surface* covered with slender appressed hairs, with scattered longer ones on costules and veins. *Sori* small, medial, lower ones not divergent; indusia bearing glands; sporangia setiferous, sometimes also a gland present.

*Distr. Malesia:* Philippines (Negros). Known from two collections, the other being ELMER 9845 which consists in part of the present species, in part of *Pneumatopteris nitidulus* (PRESL) HOLTUM.

**41. *Sphaerostephanos santomasii* HOLTUM, Kalikasan 4 (1975) 62. — Type: M. G. PRICE 1034, Luzon, Benguet Prov., Mt Santo Tomas, 2000 m (K; PNH).**

*Caudex* short, erect. *Stipe* 5–10 cm long, basal scales narrow, 8 mm long; base of stipe to first large pinna 40–75 cm. *Reduced pinnae* 3–4 cm apart, upper ones 3 mm long, lowest very small. *Lamina* to 55 cm long; pinnae to 30 pairs; several pairs lower pinnae narrowed towards their bases, a basal short pair sometimes present; aerophores to 1 mm long. *Largest pinnae* to 16 × 1.5 cm (rarely to 2 cm wide), base truncate, apex acuminate, edges lobed 3/5–2/3 to costa, lobes slightly falcate; costules 3–4 mm apart, at 60° or more; veins 7–10 pairs, basal pair anastomosing, next pair to edge or acroscopic one to sinus-membrane; *lower surface* of costae of sterile pinnae bearing pale spreading hairs 1 mm long and more numerous shorter antrorse hairs, longer hairs on fertile pinnae less than 1 mm, similar hairs more sparse on costules, surface between veins bearing glands and a variable number of slender appressed hairs; hairs on *upper surface* of costae 1 mm long, scattered similar hairs on costules and veins, whole surface covered with slender appressed hairs 0.3–0.5 mm long. *Sori* medial, lower ones not divergent; indusia small, bearing a few short hairs; sporangia copiously setiferous.

*Distr. Malesia:* Philippines (Northern Luzon: Mt Santo Tomas, Mt Nangaoto and Mt Data: ALCASID PNH 1750), at 2000 m.

**42. *Sphaerostephanos trichochlamys* HOLTUM, sp. nov.**

*Caudex brevis, erectus; stipes 8 cm longus; pinnae redactae usque 9-jugatae, superiores 3 mm longae; lamina 45 cm longa; pinnae maximae 13 × 1.7 cm, dimidio costam versus lobatae; rachis costaeque subtus pilis multis usque 1.5 mm longis vestita, pagina inter venas pilis erectis glandulisque praedita; indusia pilosa; sporangia setifera. — Type: HOLTUM 4, Mt Kinabalu (K).*

*Caudex* erect, short. *Stipe* 8 cm long, dark reddish; base of stipe to first large pinna 50 cm. *Reduced pinnae* to 9 pairs, uppermost 3 mm long, rest very small, with aerophores to 1 mm long. *Lamina* to 45 cm long; pinnae to 20 pairs, red when young, lower ones narrowed towards their bases. Hairs on *rachis*, both surfaces, to more than 1 mm long, with shorter ones also on lower surface. *Largest pinnae*  $13 \times 1.7$  cm (sterile to 2 cm wide), base (except lower ones) truncate, apex short-acuminate, edges lobed  $\frac{1}{2}$  way to costa; costules 3–4 mm apart, falcate distally; veins 7–8 pairs, thick and prominent below in sterile fronds, basal pair anastomosing, next acroscopic vein to sinus-membrane; *lower surface* of costae densely covered with spreading hairs 1–1.5 mm long and much shorter ones, similar but more sparse hairs on costules and veins; surface between veins bearing short erect hairs and glands; *upper surface* of costae densely antrorse-hairy, sparse long hairs on costules and veins, surface between veins with a variable number of fine appressed hairs. *Sori* medial, lower ones not divergent; indusia firm, bearing many hairs 0.3 mm long; sporangia copiously setiferous.

Distr. *Malesia*: Borneo (Sabah: Mt Kinabalu, many specimens; Sarawak: G. Mulu).

Ecol. In forest at c. 1500 m, not near streams; young fronds red, not mucilaginous.

Notes. This is closely allied to *S. hirsutus* but is smaller and much more densely hairy, with copiously setose sporangia. A specimen from 2275 m on G. Mulu has few sori which have small glabrous indusia.

**43. *Sphaerostephanos adenostegius* (COPEL.) HOLTUM, comb. nov.** — *Dryopteris adenostegia* COPEL. Univ. Cal. Publ. Bot. 18 (1942) 220. — *Cyclosorus adenostegius* (COPEL.) COPEL. Gen. Fil. (1947) 142; Philip. J. Sci. 78 (1951) 442, pl. 6B. — *Thelypteris adenostegia* (COPEL.) REED, Phytologia 17 (1968) 258. — Type: BRASS 10282, near Lake Habbema, New Guinea, 2800 m, in forest (GH).

*Pronephrium nothofageti* HOLTUM, Blumea 20 (1972) 118. — Type: T. G. WALKER 8788, New Guinea, Finisterre Range, 2400 m, in *Nothofagus* forest (BM).

*Rhizome* short-creeping, 3–4 mm diameter. *Stipe* commonly to 30 cm long, minutely hairy, basal scales  $5 \times 1$  mm. *Lamina* 20–30 cm long; pinnae 8–10 pairs, lower ones with stalks 1–2 mm long, lowest 1–4 pairs  $\pm$  reduced, lowest sometimes 1.3 cm long; texture firm; aerophores not elongate; frond-apex deltoid, deeply lobed. *Largest pinnae* 5–8 cm long, 1.3–1.6 cm wide, base subtruncate and sometimes slightly auricled, edges lobed about  $\frac{1}{3}$  to costa, lobes slightly dentate at ends of veins; costules  $4\frac{1}{2}$  mm apart; veins to 5 pairs, one pair anastomosing, next acroscopic vein to side of sinus-membrane; hairs on *lower surface* of

*rachis* pale,  $\pm$  curved, to 0.5 mm long, on costae 0.2–0.3 mm long, slightly antrorse, sparse glands usually present on costules and on surface between veins; hairs on *upper surface* of *rachis* as lower, on costae short and sparse, scattered longer hairs on costules and veins, slender appressed hairs to 0.5 mm long more or less abundant between veins. *Sori* medial; indusia small, with a few short hairs and glands; sporangia bearing 1–3 slender setae; spores with a rather broad translucent wing and cross-wings.

Distr. *Malesia*: Eastern New Guinea, several localities in forest at 2300–2900 m.

**44. *Sphaerostephanos aquatilis* (COPEL.) HOLTUM, comb. nov.** — *Dryopteris aquatilis* COPEL. Philip. J. Sci. 6 (1911) Bot. 75. — *Thelypteris aquatilis* (COPEL.) REED, Phytologia 17 (1968) 260. — Type: C. KING 182, Papua (MICH, BO, NSW, P).

*Dryopteris caudiculata* ROSENST. Fedde Repert. 9 (1911) 426, non v.A.v.R. 1908. — Type: as above (BO).

*Caudex* short, erect. *Stipe* to 18 cm long, pale with dark base, short-hairy. *Lamina* to 45 cm long, apical section narrowly triangular and deeply lobed; pinnae 20 pairs or more, well spaced, lower 3–4 pairs gradually smaller, lowest 0.8–1.3 cm long; in smaller fronds only 1 pair pinnae somewhat reduced. *Largest pinnae* of type collection  $8.5 \times 1.0$  cm, of BRASS 6725  $14 \times 0.8$  cm; base very narrowly cuneate on basiscopic side, at c.  $45^\circ$  on acroscopic; apex acuminate; edges very slightly crenate; costules little over 2 mm apart, at  $45^\circ$ ; veins of type 3 pairs, 2 pairs anastomosing; sinus-membrane hardly evident; hairs on *lower surface* of costae copious, antrorse, on costules sparse, rest of lower surface glabrous, glands present on costae and costules only of type (also between veins on BRASS 6725); *upper surface* bearing hairs on costae only, sparse distally. *Sori* medial to supramedial; indusia rather large, glabrous or sometimes bearing glands or a few short hairs; sporangia bearing glands.

Distr. *Malesia*: S.E. Papua New Guinea; 2 collections (BRASS 6725, Fly River).

Ecol. At low altitude by streams in flood zone.

Note. Possibly not distinct from *S. mutabilis*.

**45. *Sphaerostephanos hispidifolius* (v.A.v.R.) HOLTUM, comb. nov.** — *Dryopteris hispidifolia* v.A.v.R. Bull. Jard. Bot. Btzig II, 20 (1915) 15; Handb. Suppl. (1917) 186. — *Thelypteris hispidifolia* (v.A.v.R.) REED, Phytologia 17 (1968) 283. — Lectotype (selected here): JAHERI 1124, Borneo (BO).

*Nephrodium hispidulum* (non (DECNE) BAK.) CHRIST, Ann. Jard. Bot. Btzig 20 (1906) 107. — Fig. 121-m.

*Caudex* short-creeping, with a dense mass of roots. *Stipe* 6–10 cm long, slender, reddish, short-

hairy; basal scales 4 mm long, narrow; base of stipe to first large pinna 10–17 cm. *Reduced pinnae* usually 1–2 pairs, 1–2 mm long, rarely lacking. *Lamina* 20–30 cm long, apex not pinna-like; pinnae 10–15 pairs, lower ones with stalks 1–2 mm long; texture firm, aerophores not enlarged. *Largest fertile pinnae* 3.5–6 cm long, 0.6–0.8 cm wide (sterile to  $7.5 \times 0.9$  cm), base narrowly cuneate on basiscopic side, more broadly on acroscopic, apex acuminate, edges lobed  $\frac{1}{2}$  way to costa (or more deeply in largest pinnae), lobes oblique; costules 3 mm apart, at  $45^\circ$  to costa; veins 3–4 pairs, basal acroscopic vein ending exactly at base of sinus, basal basiscopic vein to edge very near base of sinus; rather sparse stiff hairs to 1 mm long on lower surface of rachis, base of costae and margins of lobes, costa distally glabrous, some glands present on lower surface between veins; upper surface of pinnae glabrous apart from slender hairs 0.5 mm long on costae. *Sori* medial; indusia firm, glabrous; sporangia bearing glands.

Distr. *Malesia*: Borneo; collections from several localities.

Ecol. On rocks and earth of stream banks, in the flood zone.

Note. v.A.v.R. in the Supplement to his Handbook describes the basal veins “uniting at or a little below the sinus”, but in the specimens examined by me they usually end separately, though near together, their tips sometimes touching near base of pinnae.

**46. *Sphaerostephanos uniauriculatus*** (COPEL.) HOLTUM, *comb. nov.* — *Dryopteris uniauriculata* COPEL. Philip. J. Sci. 9 (1914) Bot. 3. — *Thelypteris uniauriculata* (COPEL.) REED, Phytologia 17 (1968) 322. — Type: C. KING 406, Papua (MICH; BM, P).

*Caudex* short, suberect or creeping. *Stipe* 20–27 cm long, minutely hairy. *Reduced pinnae* one on each side of rachis, not opposite, c. 5 mm long. *Lamina* consisting of a large terminal leaflet and 2 pinnae (not opposite), sometimes a second pair also; aerophores slightly swollen. *Apical lamina* c. 18 cm long, fertile 3.4–3.7 cm wide, sterile 4.2 cm; base truncate or cordate, edges crenate; costules 5 mm apart along midrib; veins 8 pairs, almost all anastomosing; texture firm. *Sterile pinnae* to  $8 \times 3.2$  cm, widest  $\frac{1}{3}$  from apex, base broadly rounded to truncate, apex short-pointed, edges irregularly sinuous; costules 4–4.5 mm apart; veins 6 pairs, 3 distal veins reaching the margin, rest anastomosing; sinus-membrane hardly developed; hairs on lower surface of costae, costules and veins very short, somewhat antrorse, a few short hairs and some glands on surface between veins; upper surface glabrous apart from hairs on costae and costules. *Fertile pinnae* to  $6.5 \times 2.5$  cm; sori exindusiate, distal ones medial, lower ones divergent, those on basal veins of adjacent costules sometimes confluent; sporangia bearing glands.

Distr. *Malesia*: Papua, known only from type and KING 383 (P).

Note. KING 383 includes a young plant which has a cordate-based apical lamina and one pair of pinnae  $6 \times 8$  mm, also an older plant with 2 pairs of pinnae and a single reduced pinna. COPELAND stated that there is a group of hairs in place of an indusium, but I did not see this.

**47. *Sphaerostephanos urdanetensis*** (COPEL.) HOLTUM, *comb. nov.* — *Dryopteris urdanetensis* COPEL. in Elmer Leaflet. Philip. Bot. 5 (1913) 1682. — *Cyclosorus urdanetensis* (COPEL.) COPEL. Gen. Fil. (1947) 143; Fern Fl. Philip. (1960) 355. — *Thelypteris urdanetensis* (COPEL.) REED, Phytologia 17 (1968) 322. — Type: ELMER 13762, Mindanao, Mt Urdaneta (MICH).

*Dryopteris matutumensis* COPEL. Philip. J. Sci. 40 (1929) 299, pl. 3. — *Cyclosorus matutumensis* (COPEL.) COPEL. Gen. Fil. (1947) 143; Fern Fl. Philip. (1960) 355. — *Thelypteris matutumensis* (COPEL.) REED, Phytologia 17 (1968) 291. — Type: COPELAND s.n. May 1917, Mindanao, Mt Matutum, 2000 m (MICH; UC).

*Caudex* short, creeping; base of stipe to first normal pinna 3–5 cm (sterile), 10–18 cm (fertile); *reduced pinnae* 2–3 pairs, to 4–5 mm long. *Lamina* excluding reduced pinnae to 20 cm long, consisting of an apical lamina 12–15 cm long, to 3 cm wide, deeply lobed and grading to pinnae at its base, with 3–5 pairs of free pinnae; basal pinnae narrowed towards their bases on basiscopic side, widest  $\frac{1}{3}$  from apex. *Largest pinnae*  $1.5 \times 0.8$  cm (type of *D. matutumensis*); apex broadly pointed to rounded; edges crenate; costules 2 mm apart; veins 2–3 pairs, one pair anastomosing near base of pinna, free elsewhere; lower surface of rachis bearing thick curved pale brown hairs 0.5 mm long, hairs on costae shorter, yellow glands present throughout; upper surface of rachis as lower, of pinnae covered throughout with slender appressed hairs. *Sori* on apical lamina medial or supramedial, on pinnae near costae, one on each basal vein; indusia small, dark, firm, glabrous or with a few glands or short hairs; sporangia bearing glands.

Distr. *Malesia*: Philippines (Mindanao).

Note. The type of *D. matutumensis* has larger fronds than that of *D. urdanetensis* and has a few hairs on indusia, but agrees in other characters.

**48. *Sphaerostephanos batjanensis*** (ROSENST.) HOLTUM, *comb. nov.* — *Dryopteris batjanensis* ROSENST. Meded. Rijksherb. n. 31 (1917) 5. — *Thelypteris batjanensis* (ROSENST.) REED, Phytologia 17 (1968) 263. — Type: DE VRIESE & TEYSMANN 589, Moluccas, Batjan (L).

*Aspidium canescens forma gymnogammoides* CHRIST, Ann. Jard. Bot. Btzg 15 (1898) 131. — Type: SARASIN 137, N. Celebes, G. Masarang (BAS).

*Caudex* short, erect. *Base of stipe* to first large pinna of sterile fronds 5–12 cm, of fertile to 30 cm. *Reduced pinnae* 1–2 pairs, very small, irregularly spaced. *Lamina* to 30 cm long; pinnae 12–15 pairs, basal 2–3 pairs deflexed and slightly reduced, lowest narrowed towards base on basiscopic side. *Sterile pinnae* to 3.5 cm long, 1.2 cm wide above base which is a little dilated and sometimes auricled on acroscopic side; apex abruptly short-pointed; edges lobed to a depth of 1.5 mm; costules 3 mm apart; veins to 6 pairs, pale and prominent on lower surface, 1½ pairs anastomosing, next pair to sinus-membrane; *lower surface* of rachis, costae and costules covered with appressed pale hairs 0.3–0.4 mm long, copious glands on surface between veins; *upper surface* of pinnae covered throughout with slender appressed hairs 0.3 mm long, no glands; hairs on rachis more than 0.5 mm long. *Fertile pinnae* a little smaller than sterile; sori almost covering lower surface; indusia firm, rather large, hairy; sporangia bearing glands.

Distr. *Malesia*: N. Celebes & Moluccas (Batjan, Ceram).

Note. The specimen of DE VRIESE & TEYSMANN 589 at Kew is labelled Ceram, not Batjan; it agrees with the Leiden specimen.

**49. *Sphaerostephanos humilis* HOLTUM, sp. nov.**

*Pinnae* 5-jugatae, usque 1.6 × 1.1 cm, inferiores non decrescentes, subtus ubique glanduliferae, supra pilis adpressis vestitae; sori mediales; indusia magna, glandulis pilisque brevibus praedita; sporangia copiose glandulifera. — Type: W. MEIJER 9826, Central Celebes, Mt Nokilalaki, 1500–2000 m (L).

*Caudex* short-creeping; *stipe* of sterile fronds 4–5 cm, of fertile 6–13 cm, short-hairy throughout, basal scales thin, c. 3 × 1.5 mm. *Sterile frond* to c. 14 cm long, consisting of an apical lamina 8.5 cm long, 1.2 cm wide, lobed to a depth of 2–2.5 mm, and 5 pairs of pinnae, basal pinnae variably somewhat reduced, no very small reduced pinnae present; *largest pinnae* 1.6 × 1.1 cm, subsessile, widening from the base to widest part near apex, irregularly shallowly lobed (most deeply towards apex) with 3–4 lobes on each side; costules 3–5 mm apart; veins to 4 pairs, basal pair anastomosing, next pair to margin; *lower surface* of rachis bearing rather sparse pale hairs 0.4 mm long, costae covered sparsely with very short appressed hairs, glands copious throughout lower surface which is not pustular; *upper surface* of rachis hairy as lower, whole upper surface of pinnae covered with appressed hairs 0.3 mm long. *Fertile fronds* with apical lamina a little narrower than sterile, edges of lobes dentate at ends of veins; pinnae to 1.4 × 0.9 cm; sori medial; indusia rather large, firm, with a few glands and usually a few short hairs; sporangia copiously glandular; spores spinulose.

Distr. *Malesia*: Central Celebes. Only known from the type.

**50. *Sphaerostephanos lastreoides* (PRESL) HOLTUM**, *Kalikasan* 4 (1975) 54. — *Pronephrium lastreoides* PRESL, *Epim. Bot.* (1851) 259; Holtum, *Novit. Bot. Univ. Carol. Prag.* 1968 (1969) 49. — Type: "Java (JUNGHUHN, comm. Vriese 1850)" (PRC).

*Cyclosorus duplosetosus* COPEL. *Philip. J. Sci.* 81 (1952) 32; *Fern Fl. Philip.* (1960) 354. — *Thelypteris duplosetosus* (COPEL.) REED, *Phytologia* 17 (1968) 274. — Type: MERRILL 9530, Palawan, Mt Capoas (MICH).

*Caudex* short, creeping. *Stipe* to 5 cm (sterile), to 15 cm (fertile) covered with short pale hairs; base of stipe to first large pinna 10–20 cm. *Reduced pinnae* 1–2 pairs, small, irregularly spaced. *Lamina* to 15 cm long; free pinnae c. 10 pairs, lower ones with short stalks and narrowed at base on basiscopic side; apical lamina short, acuminate; aerophores not elongate. *Supramedial pinnae* to 2.3 × 0.9 cm, base truncate, apex abruptly obtuse-pointed, lobed to about ½ way to costa; costules 3 mm apart; veins 3–4 pairs, basal pair anastomosing with excurrent vein to sinus, next pair to edge; sparse pale spreading hairs 1 mm long and many much shorter ones on *lower surface* of costae and costules, glands on surface between veins; scattered long hairs on *upper surface* of costae, costules and veins, whole surface covered with slender appressed hairs 0.2–0.3 mm long. *Rachis* also with spreading hairs 1 mm long and shorter ones on both surfaces. *Sori* medial; indusia with short hairs; sporangia bearing glands.

Distr. *Malesia*: Philippines (Palawan, Luzon, Negros, Mindanao).

Notes. Part of CUMING 251 from Luzon, in several herbaria, exactly matches the type of this species; nothing like it is otherwise known from Java. Probably the type was a CUMING specimen misplaced by PRESL. M. G. PRICE 2734, from Mindanao, Agusan del Sur Prov., is like the type in all essentials but a little larger; its fertile pinnae are the same size as sterile pinnae on the Kew specimen of CUMING 251, which has smaller fertile ones.

M. G. PRICE 690, from Mt Halcon, Mindoro, differs from the above description only in larger size: lamina to 35 cm long, pinnae 20 pairs, largest 7 × 1.7 cm. It may represent a distinct local variety.

A. LOHER s.n. March 1915, from Rizal Province, Luzon, differs in having shallowly crenate pinnae, and slender appressed hairs on lower surface of costules.

**51. *Sphaerostephanos cataractorum* (WAGN. & GRETH.) HOLTUM, comb. nov.** — *Cyclosorus cataractorum* WAGN. & GRETH. *Un. Cal. Publ. Bot.* 23 (1948) 50, pl. 16. — *Thelypteris catarac-*



torum (WAGN. & GRETH.) REED, *Phytologia* 17 (1968) 266. — Type: GRETHER & WAGNER 3971, Admiralty Islands, Manus I. (UC; NSW).

*Caudex* short, erect. *Stipe* 10–20 cm long, pallid; basal scales narrow, 5 mm long. *Lamina* to 30 cm long; pinnae to 16 pairs; basal pinnae reduced, sometimes one or both to a very narrow leaflet less than 1 cm long; apex of frond sometimes almost pinna-like; texture thin; aerophores not elongate. *Largest pinnae* to  $10 \times 0.9$  cm, widest at middle, base very narrowly cuneate, apex acuminate, edges lobed  $\frac{1}{2}$  way to costa, lobes very oblique, slightly falcate, acute; costules 4–4.5 mm apart, at  $45^\circ$ ; veins 5–6 pairs, basal pair anastomosing with excurrent vein to sinus, next acroscopic vein to side of short sinus-membrane; lower surface of pinnae quite glabrous with resinous pale glands between veins; upper surface short-hairy on costae, otherwise glabrous. *Rachis* glabrous on lower surface or with very short hairs; hairs on upper surface thick, brown, curved, 0.3–0.4 mm long. *Sori* medial; indusium firm, glabrous; sporangia bearing glands.

*Distr.* Admiralty Islands, New Britain, Bougainville, in *Malesia*: Eastern New Guinea.

*Ecol.* By streams in flood-zone at altitudes to 250 m.

*Note.* This is very similar to *S. hispidifolius* of Borneo, but has veins always anastomosing and almost glabrous pinnae. The resinous glands on lower surface are usually flattened when dry, not spherical as normally in this genus.

**52. *Sphaerostephanos menadensis* HOLTUM, sp. nov.**

*Pinnae redactae* 2-jugatae, minutae; lamina 20 cm longa, pars apicalis angusta 10 cm longa; pinnae 6-jugatae, infimae basin versus valde angustatae, mediales  $5.5 \times 1.6$  cm, dimidio costam versus lobatae; costae subtus pilis minutis vestitae; pagina inter venas subtus glandulifera, supra eglandulosa; indusia glabra, sporangia setifera. — Type: KOORDERS 17133, Celebes, Menado, 1800–2000 m (L).

Base of *stipe* to first large pinna 25 cm. *Reduced pinnae* 2 pairs, very small and widely spaced. *Terminal lamina* 10 cm long, narrowly deltoid; free pinnae 6 pairs, lowest deflexed and gradually much narrowed towards their bases, widest above middle; aerophores not elongate. *Middle pinnae* to  $5.5 \times 1.6$  cm, base truncate, apex abruptly caudate, edges lobed  $\frac{1}{2}$  way to costa, lobes falcate; costules 3.5 mm apart, at more than  $60^\circ$ ; veins 6 pairs (fertile) 7–8 pairs (sterile), 1 pair anastomosing, next pair of the acroscopic one only to sinus-membrane; long coarse hairs on lower surface of rachis, very short ones on costae and costules, surfaces between veins bearing glands only; hairs on upper surface of costules and veins all very short, neither hairs nor glands between veins. *Sori* medial; indusia glabrous; sporangia bearing glands.

*Distr. Malesia*: N.E. Celebes; only known from the type.

**53. *Sphaerostephanos subcordatus* HOLTUM, sp. nov.**

*Pinnae redactae* unijugatae, parvae; frondes dimorphae; pinnae usque 8-jugatae, steriles  $3 \times 1.2$  cm, fertiles  $1.7 \times 0.9$  cm, usque  $\frac{1}{3}$  costam versus lobatae; costae subtus brevi-pilosae, pagina inter venas glabra glandulis paucis praedita; pagina superior inter venas glabra, eglandulosa. indusia parva, glabra; sporangia glandulosa. — Type: M. G. PRICE & B. F. HERNAEZ 61, Western Samar (K).

*Caudex* short, creeping, 3 mm diameter when dry. *Stipe* of sterile fronds 5–7 cm, of fertile 15–18 cm to first large pinna below which are 2 much-reduced pinnae, not opposite. *Lamina* 15 cm long, apex broadly deltoid and deeply lobed, free pinnae to 8 pairs, basal ones slightly reduced, deflexed, with stalks 1 mm long and asymmetric base; aerophores not elongate. *Largest sterile pinnae*  $3 \times 1.2$  cm, in some cases 1.5 cm wide near apex; base truncate to subcordate; apex abruptly blunt-pointed; edges lobed to a depth of 2 mm, more deeply near apex if it is widened, lobes rounded; costules 4 mm apart, at less than  $60^\circ$ ; veins 4–5 pairs, basal pair anastomosing, next acroscopic vein to sinus-membrane; hairs on lower surface of costae 0.2 mm long, antrorsely curved, more sparse and shorter on costules, surface between veins glabrous with a few glands; hairs on upper surface of costae sparse, 0.4 mm long, similar or longer ones scattered on costules and veins; surface between veins glabrous. Hairs on lower surface of rachis 0.3–0.4 mm long, thick and curved, on upper surface rather sparse, 1 mm long. *Sori* medial, lower ones sometimes a little elongate; indusia small, glabrous; sporangia with glands.

*Distr. Malesia*: Philippines (W. Samar), only known from the type.

*Ecol.* On limestone-derived soils, in forest.

**54. *Sphaerostephanos novoguineensis* (BRAUSE) HOLTUM, comb. nov. — *Dryopteris novoguineensis* BRAUSE, Bot. Jahrb. 49 (1912) 21; v.A.v.R. Handb. Suppl. (1917) 159. — *Lastrea novoguineensis* (BRAUSE) COPEL. Gen. Fil. (1947) 139; Philip. J. Sci. 78 (1951) 426. — *Thelypteris novoguineensis* (BRAUSE) REED, *Phytologia* 17 (1968) 297. — Type: SCHLECHTER 17719, N.E. New Guinea, Kani Mts, 1000 m (B; P).**

*Dryopteris glaucescens* BRAUSE, Bot. Jahrb. 56 (1920) 85; COPEL. Philip. J. Sci. 78 (1951) 426. — *Thelypteris glaucescens* (BRAUSE) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 251. — Type: LEDERMANN 13034, N.E. New Guinea, Sepik Dist. 1400 m (B).

*Caudex* short, creeping. *Stipe* 10–15 cm long; basal scales thin,  $10 \times 2.5$  mm; base of *stipe* to first large pinna 20–45 cm. *Reduced pinnae* 3–8 pairs,

not more than 3 mm long. *Lamina* to 80 cm long; pinnae to 25 pairs, lower ones not narrowed at base; aerophores to more than 1 mm long. *Pinnae* somewhat dimorphous, sterile to  $10 \times 1.7$  cm, fertile to  $7.5 \times 1.2$  cm; base truncate, basal acroscopic lobe to 4 mm longer than next; apex short-acuminate; edges lobed to less than 1 mm from costa, lobes falcate; costules 3 mm apart (sterile), 2.5 mm (fertile); veins 10 pairs, basal acroscopic vein passing to side of sinus-membrane, basiscopic vein to edge above it; *lower surface* of costae bearing many short hairs and less abundant long ones to 1 mm (long hairs sometimes lacking), similar hairs on costules, glands sometimes few present on surface between veins; *upper surface* with hairs 1 mm long scattered on costae, costules and veins, surface between veins  $\pm$  closely covered with fine appressed hairs. *Sori* medial to supramedial; indusia large, firm, with short hairs and sometimes glands; sporangia bearing glands; spores finely spinulose.

Distr. *Malesia*: Eastern New Guinea, several collections, in forest at 850–1400 m.

Note. The type of *D. glaucescens* differs from that of *D. novoguineensis* in the absence of long hairs on lower surface of rachis and costae and the presence of glands on indusia.

**55. *Sphaerostephanos hispiduliformis*** (C. CHR.) HOLTUM, *comb. nov.* — *Dryopteris hispiduliformis* C. CHR. Ind. Fil. Suppl. III (1934) 88, new name for *Dryopteris hispidula* BRAUSE, Bot. Jahrb. 56 (1920) 102, non (Sw.) O. Ktze 1891. — *Thelypteris hispiduliformis* (C. CHR.) REED, Phytologia 17 (1968) 283. — Type: LEDERMANN 11758, N.E. New Guinea, Sepik Distr. 2070 m, in forest (B).

#### KEY TO THE VARIETIES

1. Caudex to 150 cm tall; lower surface of pinnae lacking glands between veins

a. *var. hispiduliformis*

1. Caudex short; lower surface of pinnae between veins copiously glandular.

2. Fronds to 90 cm long; pinnae to  $14 \times 1.5$  cm; hairs on lower surface of costae 0.1 mm long

b. *var. vinkii*

2. Fronds to 40 cm long; pinnae to  $5 \times 1$  cm; hairs on lower surface of costae 1 mm long

c. *var. brassii*

#### a. *var. hispiduliformis*

*Caudex* erect, to 150 cm tall; *stipe* 10–15 cm long, basal scales broad, thin; base of stipe to pinnae of maximum size 60 cm or more, whole frond to 150 cm long; *reduced pinnae* 1.5–2.0 cm apart, broadly triangular, c. 12 pairs gradually increasing upwards from very small basal ones to 1 cm, then 7–12 pairs grading to pinnae of maximum size; aerophores more than 1 mm long. *Largest pinnae* 11 cm long, to 1.7 cm wide at

dilated base, rather evenly tapered to apex, lobed c. 2/5 towards costa; costules to 3.5 mm apart, at more than 60° to costa; veins 7–9 pairs,  $1\frac{1}{2}$  pairs anastomosing, 1–1 $\frac{1}{2}$  pairs ending beside sinus-membrane; *lower surface* of costae with spreading pale hairs 1 mm long and shorter ones, hairs on costules more sparse, a few short hairs between veins, glands confined to costules and veins, sometimes lacking; hairs on *upper surface* of costae more than 1 mm long, scattered similar hairs on costules and veins, fine appressed hairs all over surface. *Sori* medial; indusia bearing hairs and glands, sporangia with neither; spores covered with very small warts.

Distr. *Malesia*: Eastern New Guinea, in mountain forest at c. 2000 m.

#### b. *var. vinkii* HOLTUM, *var. nov.*

A *typo speciei differt*: *caudice brevis*; *pinnis 1/3 costam versus lobatis*; *costis subtus pilis minutis erectis vestitis*; *pagina inferiore inter venas copiose glandulifera*. — Type of variety: VINK 17605, N.E. New Guinea, W. Sepik Distr., in low secondary growth on limestone (L).

Distr. *Malesia*: Papua New Guinea (Sepik).

**c. *var. brassii* HOLTUM, *var. nov.*** — *Dryopteris strigosissima* COPEL. Univ. Cal. Publ. Bot. 18 (1942) 221. — *Cyclosorus strigosissimus* (COPEL.) COPEL. Gen. Fil. (1947) 143; Philip. J. Sci. 78 (1951) 456, pl. 36. — *Thelypteris strigosissima* (COPEL.) REED, Phytologia 17 (1968) 316. — Type: BRASS 11436, New Guinea, Bele River, 2200 m, on limestone cliff in shade (MICH).

Differs from *var. vinkii*: fronds much smaller; reduced pinnae contiguous, lower ones wider than long; largest pinnae  $5 \times 1$  cm, crenate to a depth of 1 mm; long hairs present on lower surface of costae.

Distr. *Malesia*: Papua New Guinea.

Notes. The greater number of glands on the lower surface may be due to the limestone habitat of *var. vinkii* and *var. brassii* (plants of *S. heterocarpus* on limestone are densely glandular), also their short caudex. But there is no evidence that LEDERMANN's type did not grow on limestone. When more information is available it may be better to regard *var. vinkii* and *var. brassii* as representing a distinct species, for which COPELAND's epithet *strigosissimus* would be available.

**56. *Sphaerostephanos hastatopinnatus*** (BRAUSE) HOLTUM, *comb. nov.* — *Dryopteris hastatopinnata* BRAUSE, Bot. Jahrb. 56 (1920) 112. — *Thelypteris hastatopinnata* (BRAUSE) REED, Phytologia 17 (1968) 281. — Type: LEDERMANN 8237, N.E. New Guinea, Sepik Distr., 200 m on rocks in stream-bed in forest (B; K).

Plants varying much in size according to habitat. *Caudex* erect, short. *Stipe* 3–4 cm on type, to

15 cm on large plant. *Lamina* of type 45 cm long, of large plant 130 cm; pinnae 28 pairs on type, 35 pairs on large plant; 10–20 pairs lower pinnae in all cases gradually smaller, lowest 5–10 mm long; apex of frond almost pinna-like; aerophores distinctly swollen, to almost 1 mm long in large fronds. *Reduced pinnae* broadly and symmetrically triangular, spreading, subentire. *Largest pinnae* of type  $10 \times 1.3$  cm, of a large plant  $20 \times 3.0$  cm; base truncate, dilated and more or less auricled both sides (upper ones auricled on acroscopic side only), apex short-acuminate, edges sinuous or slightly crenate; costules of small plants 2.5–3 mm apart, of a large one to 4.5 mm, at more than  $60^\circ$ ; veins 3–7 pairs, almost all anastomosing; sinus-membrane hardly developed; *lower surface* of pinnae quite glabrous or with a few hairs on costae, glands sometimes present on and between veins; hairs on *upper surface* of costae slender, brown, to 0.5 mm long, none elsewhere, a few glands rarely present. Lower surface of *rachis* glabrous or with sparse appressed hairs, upper surface bearing copious reddish-brown hairs 1 mm long. *Sori* medial, lower ones  $\pm$  elongate and sometimes confluent; no indusia; sporangia bearing glands.

Distr. *Malesia*: Central Celebes, Moluccas (Ceram) and widely distributed in New Guinea.

Ecol. On river banks in forest at low altitudes, up to 650 m. The type was probably stunted owing to its rocky habitat and perhaps exposed position.

**57. *Sphaerostephanos latebrosus*** (KUNZE ex METT.) HOLTUM in Nayar & Kaur, Comp. to Bedd. (1974) 209. — *Aspidium latebrosum* KUNZE ex METT. Farngatt. IV (1858) 104; BAK. Syn. Fil. (1867) 294; MIQUEL, Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 159. — *Dryopteris latebrosa* (METT.) C. CHR. Ind. Fil. (1905) 274; v.A.v.R. Handb. (1908) 221. — *Thelypteris latebrosa* (METT.) REED, Phytologia 17 (1968) 287. — Type: ZOLLINGER 354 pt, Java (L, n. 908, 333–517 only).

*Nephrodium glaucostipes* BEDD. Handb. Suppl. (1892) 80. — *Dryopteris glaucostipes* (BEDD.) C. CHR. Ind. Fil. (1905) 268; Gard. Bull. Str. Sett. 4 (1929) 389; v.A.v.R. Handb. (1908) 226. — *Cyclosorus heterocarpus* var. *glaucostipes* (BEDD.) HOLTUM, Rev. Fl. Mal. 2 (1955) 271. — *Thelypteris heterocarpus* var. *glaucostipes* (BEDD.) REED, Phytologia 17 (1968) 282. — Type: KING's Collector (KUNSTLER) 2046, Perak, Larut (K; CAL, SING).

*Dryopteris todayensis* CHRIST, Philip. J. Sci. 2 (1907) Bot. 193; v.A.v.R. Handb. Suppl. (1917) 184. — *Cyclosorus todayensis* (CHRIST) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 249; COPEL. Fern Fl. Philip. (1960) 344. — *Thelypteris todayensis* (CHRIST) REED, Phytologia 17 (1968) 319. — *Sphaerostephanos todayensis* (CHRIST) HOLTUM, Kalikasan 4 (1975) 58. — Type:

COPELAND 1463, Mindanao, Mt Apo 1220 m (P; US, B).

*Dryopteris angustipes* COPEL. Philip. J. Sci. 7 (1912) Bot. 60; v.A.v.R. Handb. Suppl. (1917) 184. — *Thelypteris angustipes* (COPEL.) REED, Phytologia 17 (1968) 260. — Type: BROOKS 110, Sarawak (MICH; BM).

*Cyclosorus sagittifolioides* COPEL. Philip. J. Sci. 81 (1952) 29, 30, pl. 21; Fern Fl. Philip. (1960) 344. — *Thelypteris sagittifolioides* (COPEL.) REED, Phytologia 17 (1968) 311. — Type: EDANO BS 24832, Samar, Catubig River (US).

*Cyclosorus halconensis* COPEL. Philip. J. Sci. 81 (1952) 29; Fern Fl. Philip. (1960) 345. — *Thelypteris halconensis* (COPEL.) REED, Phytologia 17 (1968) 305. — Type: EDANO PNH 3849, Mindoro, Mt Halcon (MICH; L).

*Cyclosorus polypterus* COPEL. Philip. J. Sci. 84 (1955) 161. — *Thelypteris polyptera* (COPEL.) REED, Phytologia 17 (1968) 305. — Type: EDANO 7852 (PNH 21373), Negros, Canlaon Volcano 650 m (MICH).

*Caudex* erect, not or little branched at base. *Stipe* 6–12 cm long; base of stipe to first large pinna 45–70 cm. *Reduced pinnae* 10–15 pairs, 2.5–4 cm apart, lowest commonly 5 mm long, gradually increasing upwards to 2.5–3 cm, larger ones narrowly triangular, somewhat deflexed, with acroscopic auricle, edges incised, apex broad-pointed; transition to large pinnae subabrupt; aerophores elongate, in some cases 1 mm or rarely more (type of *C. sagittifolioides*). *Lamina* above reduced pinnae to 60 cm or more long; basal large pinnae not narrowed at base. *Rachis* lower surface commonly quite glabrous, in some specimens with sparse long hairs or some very short ones; hairs on upper surface to 1 mm long, usually appressed (spreading in some Philippine specimens). *Largest pinnae*  $12 \times 1.6$  to  $20 \times 2.0$  cm; base truncate, usually a little dilated both sides; apex acuminate; edges lobed about half-way to costa or a little more in large pinnae; costules 3.5–4.5 mm apart; veins 7–8 pairs, basal pair anastomosing, one or both of next pair to sinus-membrane; *lower surface* of costae usually glabrous at base with very short antrorse hairs distally, in some cases very short hairs and a few somewhat longer throughout; costules as costae but with shorter hairs (if any); rest of lower surface usually quite glabrous with many glands; *upper surface* with long hairs on costae, similar hairs scattered on costules and veins, rest of surface bearing a variable number of fine appressed short hairs. *Sori* medial, lower ones not divergent; indusia glabrous or with a few short hairs, usually also glands; sporangia bearing glands, rarely a seta; spores with many very small wings.

Distr. *Malesia*: Western Malesia, Philippines.

Ecol. In forest, low altitudes to 800 m.

Notes. In Malaya, Sumatra and Java all lower surfaces are almost glabrous, but in nearly all

cases there are short hairs on distal parts of costae; aerophores are little elongate. In Sabah (Mt Kinabalu) and the Philippines some hairs are nearly always present and aerophores are more developed. In the type of *Cyclosorus sagittifolioides* some aerophores are 2 mm long, and short erect hairs are present on lower surface between veins.

Some Philippine specimens seem rather intermediate between this species and *S. hirsutus*; they may be hybrids. Hybrids with *S. heterocarpus* in Sabah are also possible. The solitary erect caudex of *S. latebrosus*, large upper reduced pinnae and broad base of lowest normal pinnae seem distinctive.

**58. *Sphaerostephanos porphyricola* (COPEL.) HOLTUM**, *Kalikasan* 4 (1975) 59. — *Dryopteris porphyricola* COPEL. *Philip. J. Sci.* 7 (1912) Bot. 60; v.A.v.R. *Handb. Suppl.* (1917) 186. — *Thelypteris porphyricola* (COPEL.) CHING, *Bull. Fan Mem. Inst. Biol. Bot.* 6 (1936) 287, *nomen tantum*. — *Cyclosorus porphyricola* (COPEL.) CHING, *Bull. Fan Mem. Inst. Biol. Bot.* 10 (1941) 248; HOLTUM, *Rev. Fl. Malaya* 2 (1955) 271. — Type: BROOKS 112, Sarawak, Bau (MICH; BM). *Dryopteris angustipes sensu* C. CHR. *Gard. Bull. Str. Settl.* 4 (1929) 389.

*Caudex* erect, short. *Stipe* 10 cm long; base of stipe to first large pinna 35 cm. *Reduced pinnae* to 12 pairs, 1.5 cm apart, uppermost 1–1.5 cm long, deflexed, narrowly triangular with auricle on acroscopic base, edges incised, lowest ones 3–5 mm long. *Lamina* 55 cm long; pinnae to 20 pairs or more, lowest ones narrowed a little at base on basiscopic side only; aerophores elongate, to less than 1 mm long; young fronds covered with mucilage. Lower surface of *rachis* almost glabrous or with very short hairs, also many glands; upper surface copiously hairy. *Largest pinnae* 14 × 2.5 cm (sterile to 15 × 3 cm), base subtruncate, apex abruptly short-acuminate; edges lobed 2/5 to costa, lobes distinctly falcate with forward-pointing tips; costules 3–4.5 mm apart; veins 7–9 pairs, 1 pair anastomosing, next pair to sinus-membrane; lower surface of costae, costules and veins covered with fine short closely appressed hairs, also glands; surface between veins bearing copious glands and a variable number of short fine appressed hairs; hairs on upper surface of costae antrorse, pale, similar hairs sometimes scattered on costules and veins, surface between veins typically covered closely with slender appressed hairs 0.5 mm long, fewer such hairs on specimens from Malaya. *Sori* medial, lower ones not divergent but sometimes a little elongate; indusia bearing short hairs and glands; sporangia with glands.

*Distr. Malesia*: Malaya and Borneo (Sarawak; Sulu Arch.: Tawi-Tawi).

*Ecol.* In forest at low altitudes.

*Note.* This is closely allied to *S. latebrosus*; more field observations are needed.

**59. *Sphaerostephanos caulescens* HOLTUM, sp. nov.** — *Dryopteris porphyricola* (non COPEL.) C. CHR. *Gard. Bull. Str. Settl.* 7 (1934) 244.

*Caudex erectus*; *stipes* 5 cm longus; *pinnae redactae* usque 8-jugatae, omnes minutae; *aerophora* 1 mm longa; *pinnae majores* 13.5 × 1.5–2.0 cm, *dimidio costam versus lobatae*; *rachis subtus fere glabra*; *pagina inter venas subtas glandulifera*, *supra pilis appressis venata*; *indusia fere glabra*; *sporangia glandulifera*. — Type: G. P. LEWIS 284, Sarawak, G. Mulu (K).

*Caudex* erect, to at least 20 cm tall. *Stipe* 5 cm long, base covered with large thin scales; base of stipe to first large pinna 40 cm. *Reduced pinnae* to 8 pairs, when young covered with mucilage, all very small, with aerophores 1 mm long. Lower surface of *rachis* often bearing narrow scales, otherwise almost glabrous, upper surface with hairs 1 mm long closely appressed, with some longer and spreading. *Lamina* to 75 cm long; pinnae to more than 30 pairs, not opposite; basal pinnae (at least sterile ones) narrowed at their bases. *Largest fertile pinnae* 13.5 × 2.0 cm (sterile sometimes larger, to 20 × 3 cm); base truncate; apex acuminate (sometimes with cauda 1.5 cm long); edges lobed about ½ way to costa; costules c. 3.5 mm apart, at 60°; veins c. 7 pairs, 1 pair anastomosing, next pair to sides of sinus-membrane; lower surface of costae almost glabrous at base, with appressed hairs to 0.2 mm long distally, costules similar, surfaces between veins bearing copious glands; hairs on upper surface of costae to 1 mm long, similar hairs scattered on costules and veins, short appressed hairs on surface between veins. *Sori* medial, lower ones not divergent; indusia glabrous or with few very short hairs; sporangia bearing glands.

*Distr. Malesia*: Borneo (N. Sarawak; Sabah), N. Celebes, and Moluccas (Batjan).

*Ecol.* In forest near streams at 500–1500 m.

*Note.* This is near *S. magnus*, but pinnae of *S. caulescens* (except largest sterile ones) are generally smaller and less deeply lobed, with different pubescence and glandular sporangia.

**60. *Sphaerostephanos reconditus* HOLTUM, sp. nov.**

*Pinnae redactae* c. 6-jugatae, parvae; *pinnae normales* usque 7.2 × 1.5 cm, *dimidio costam versus lobatae*; *venae* 5–6-jugatae, *infirmas solum anastomosantes*; *costulae subtus pilis adpressis vestitae*; *pagina inferior inter venas pilis adpressis glandulisque praedita*; *sori mediales*; *indusia dense pilosa*; *sporangia copiose glandulifera*. — Type: B. S. PARRIS 6872, Sarawak, Gunong Mulu (CGE).

*Caudex* short, erect or suberect; *stipe* 5 cm long; base of stipe to first normal pinna 30 cm;

reduced pinnae all very small, 3–4 cm apart. *Lamina* excluding reduced pinnae 30 cm long; pinnae c. 12 pairs; basal pinnae much narrowed in basal third, above base 2 cm wide; aerophores when dried barely 0.5 mm long, on living plant "yellow". Lower surface of *rachis* densely hairy, hairs thick, curved, brown, 1 mm long with shorter pale ones (brown hairs more numerous on basal part); upper surface with thicker brown hairs and shorter pale ones. *Suprabasal pinnae* to  $7.2 \times 1.5$  cm; base truncate and slightly auricled; apex short-acuminate; edges lobed not quite half-way to costa; costules 3.5–4.5 mm apart, at c.  $60^\circ$ ; veins 5–6 pairs, hardly prominent, 1 pair anastomosing, next acroscopic vein or pair passing to sinus-membrane; lower surface of costae bearing pale antrorse hairs which are appressed distally, 0.5 mm long, also glands, costules covered with slender appressed hairs, between veins some appressed hairs and rather sparse glands; upper surface of costae bearing pale hairs, no long hairs on costules or veins, between veins sparse appressed hairs. *Sori* medial or a little inframedial, lower ones not divergent; indusia densely hairy, sometimes with a gland; sporangia bearing many glands.

Distr. *Malesia*: Borneo (Sarawak: Mt Mulu), only known from type.

Ecol. In forest clearing in Hidden Valley at 450 m; very young fronds covered with mucilage.

**61. *Sphaerostephanos cyrtocaulos*** (v.A.v.R.) HOLTUM, *comb. nov.* — *Dryopteris cyrtocaulos* v.A.v.R. Bull. Jard. Bot. Btzg III, 5 (1922) 201. — *Thelypteris cyrtocaulos* (v.A.v.R.) REED, *Phytologia* 17 (1968) 270. — Lectotype (here selected): BÜNNEMEIJER 9922, Sumatra, G. Kerinci, 2100 m (BO; L).

*Caudex* erect. *Stipe* 10–15 cm long; base of stipe to first large pinna 40–75 cm. *Reduced pinnae* 8 pairs or more, 2–3 mm long; aerophores to 2 mm long. *Lamina* to 75 cm long; pinnae more than 20 pairs, well spaced; lowest pinnae not narrowed at base, nor auricled. Hairs on both sides of *rachis* short. *Largest pinnae* of lectotype  $12 \times 2.5$  cm (possibly larger on sterile fronds); base truncate; apex acuminate with cauda to 1.5 cm; edges lobed to 2.5–3 mm from costa (about 3/4), lobes slightly falcate; costules 4–4.5 mm apart at more than  $60^\circ$ ; veins 8–11 pairs, basal pair anastomosing, next pair both to edge above base of sinus; hairs on lower surface of costae and costules 0.2 mm long, appressed, a few also on veins, glands present on and between veins; hairs on upper surface of costae 1 mm long, antrorse, similar hairs scattered on costules and veins, pale appressed hairs over whole surface. *Sori* rather supramedial; indusia firm, rather large, with short hairs; sporangia bearing glands; spores densely short-spinulose.

Distr. *Malesia*: Sumatra (on and near G. Kerinci), 1800–2300 m, in forest.

Note. VAN ALDERWERELT cited three collections by BÜNNEMEIJER without indicating a type; the largest one is here selected. One other collection is known from a neighbouring locality.

**62. *Sphaerostephanos baramensis*** (C. CHR.) HOLTUM, *comb. nov.* — *Dryopteris baramensis* C. CHR. Gard. Bull. Str. Settl. 7 (1934) 246. — *Thelypteris baramensis* (C. CHR.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 6 (1936) 287. — Type: Mjöberg 5 partim, Sarawak, Baram Valley, 900–1200 m (BM). — Fig. 13f–g.

*Caudex* short, erect. *Stipe* 5–10 cm long, basal scales thin, to 2 mm wide at base; base of stipe to first large pinna 40–60 cm. *Reduced pinnae* to 10 pairs, 4–6 cm apart, c. 2 mm long, with aerophores c. 1 mm long. *Lamina* to at least 70 cm long; pinnae to 20 pairs, lower ones often opposite, upper ones usually not; 3–4 pairs lower pinnae much narrowed towards their bases; middle pinnae often distinctly stalked; aerophores 1–2 mm long. Lower surface of *rachis* glabrous; hairs on upper surface less than 1 mm long, brown, appressed. *Largest pinnae* commonly  $15 \times 2.5$  cm, largest on type  $24 \times 4$  cm; apex of wider pinnae rather abruptly caudate-acuminate; edges lobed to 3 mm from costa; lobes falcate; costules commonly 4 mm apart, on large fronds to 7 mm; veins 10–12 pairs, prominent on lower surface, tips of basal veins touching sides of short sinus-membrane or sometimes uniting just below the sinus to form a short excurrent vein; lower surface of costae and costules covered with antrorsely curved hairs 0.2–0.3 mm long, those on costules closely appressed; surface between veins bearing a variable number of small glands and short appressed hairs; upper surface of costae bearing pale antrorse hairs less than 1 mm long, hairs on costules much shorter, surface between veins of type covered with short appressed hairs, of other specimens glabrous or with appressed hairs near costa only. *Sori* a little supramedial; indusia rather large, firm, glabrous or with short hairs; sporangia sometimes with a small gland, not setiferous.

Distr. *Malesia*: Borneo (Northern Sarawak, E. Kalimantan and Sabah), in forest at 900–1500 m.

**63. *Sphaerostephanos batulantis*** HOLTUM, *sp. nov.*

*Caudex brevis, repens; stipes* 10 cm longus; *pinnae redactae usque* 10-jugatae, superiores 4–5 mm longae; *pinnae maximae*  $11 \times 1.5$  cm, 2/3 costam versus lobatae; *costulae subtus pilis brevibus appressis vestitae, pagina inter venas glandulifera; pagina superior omnino pilis appressis vestita; sporangia glandulifera.* — Type: KOSTERMANS 18850, W. Sumbawa, Mt Batulante, 900 m (L; BO, K).

*Caudex* short, prostrate, c. 5 mm diameter. *Stipe* 10 cm long; base of stipe to first large pinna 40 cm or more. *Reduced pinnae* to 10 pairs, upper ones

4–5 mm long. *Lamina* 45 cm long; lowest pinnae narrowed to a base 5 mm wide; aerophores hardly 1 mm long. Lower surface of *rachis* densely covered with pale erect hairs 0.3 mm long, hairs on upper surface to 1 mm long, pale. *Largest pinnae* 11 × 1.5 cm; base subtruncate, not auricled; apex acuminate; edges lobed 2/3 to costa or a little more deeply, lobes falcate; costules 3–4 mm apart, at more than 60°; veins 8–9 pairs, basal pair anastomosing, next acroscopic vein sometimes to sinus-membrane; lower surface of costae hairy as rachis, hairs on distal part longer and antrorse; lower surface of costules covered with short appressed hairs; surface between veins bearing glands and a few short erect hairs; upper surface covered entirely with fine appressed hairs, no long hairs on costules or veins. *Sori* a little inframedial, lower ones not divergent; indusia thin with many hairs 0.3 mm long; sporangia bearing glands.

Distr. *Malesia*: Lesser Sunda Is. (W. Sumbawa: Mt Batulante, 900 m); only known from the type.

**64. *Sphaerostephanos subalpinus*** (v.a.v.R.) HOLTUM, *comb. nov.* — *Dryopteris subalpina* v.a.v.R. Bull. Jard. Bot. Btzg III, 5 (1922) 200. — *Thelypteris subalpina* REED, Phytologia 17 (1968) 317. — Type: BEGUIN 1496, Ternate, N. Formad-jahi, 1200 m (BO; L).

*Polypodium acutum* ROXB. Calc. J. Nat. Hist. 4 (1844) 492, non BURM. f.; MORTON, Contr. U.S. Nat. Herb. 38 (1974) 335. — Type: "Amboina" (probably C. SMITH, Ceram).

*Aspidium hispidulum* DECNE *var. ternatense* MIQ. Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 160. — Type: TEYSMANN, Ternate (L).

*Caudex* short, creeping. *Stipe* 10 cm long; base of stipe to first large pinna 30–35 cm. *Reduced pinnae* 1.5–2.0 cm apart, c. 10 pairs, upper ones 1.5 cm long, deflexed, narrowly triangular, deeply lobed, with basiscopic auricle to 10 mm long, lowest 5 mm long. *Lamina* 60–70 cm long; pinnae to 30 pairs, basal ones not narrowed at base; aerophores c. 1 mm long. Lower surface of *rachis* covered with very short hairs and sparse longer ones to 1 mm long; hairs on upper surface pale or brownish, to 1 mm long. *Largest pinnae* to 15 × 2.0 cm, base subtruncate and a little dilated both sides; apex caudate-acuminate; edges lobed to 2 mm from costa, lobes falcate, narrowed above their bases; costules to 4 mm apart; veins 8–10 pairs, basal pair anastomosing near base of pinna, near apex both touching sides of short sinus-membrane; hairs on lower surface of costae near base 0.2–0.3 mm long, suberect, distally to 0.7 mm, hairs on costules similar, glands present throughout lower surface; hairs on upper surface of costa mostly less than 1 mm long, with scattered longer ones, similar longer hairs scattered on costules and veins; a few appressed hairs sometimes present between veins. *Sori* a little

supramedial, basal ones not divergent; indusia fairly large, with a few short hairs and sometimes glands; sporangia with 1–2 glands.

Distr. *Malesia*: Moluccas (Ternate, several collections; Halmahera; Ceram?).

**65. *Sphaerostephanos lobatus*** (COPEL.) HOLTUM, *Kalikasan* 4 (1975) 64. — *Cyclosorus lobatus* (COPEL.) COPEL. Philip. J. Sci. 81 (1952) 33; Fern Fl. Philip. (1960) 356. — *Thelypteris lobata* (COPEL.) REED, Phytologia 17 (1968) 289. — Type: COPELAND 1966, Luzon, Baguio (MICH). *Dryopteris canescens* *var. lobata* CHRIST, Philip. J. Sci. 2 (1907) Bot. 198, *quoad* COPELAND 1866 (1966).

*Cyclosorus bordenii* *sensu* COPEL. Fern Fl. Philip. (1960) 345, *p.p.*

*Caudex* short, creeping. *Stipe* 5–8 cm long; base of stipe to first large pinna 40 cm or more (shorter on sterile fronds). *Reduced pinnae* 4–8 pairs, all very small with thick aerophores 1 mm long. *Lamina* commonly to 35 cm long; pinnae to c. 16 pairs; basal pinnae much narrowed towards their bases. *Rachis* bearing thick curved dark red hairs to 1 mm long on both surfaces. *Largest suprabasal pinnae* acuminate, to 15 × 1.7 cm (basal pinnae to 2 cm wide) on larger plants, on type abruptly short-pointed, c. 8 × 1.7 cm, lobed 2/3–3/4 to costa; costules to 4 mm apart; veins 7–9 pairs, basal pair anastomosing, next pair both to edge; hairs on lower surface of costae at base 0.1–0.2 mm, distally to almost 1 mm long, not appressed; hairs on costules sparse; copious glands on surface between veins; hairs on upper surface of costae less than 1 mm long, scattered similar hairs on costules and veins at least distally on pinna-lobes, surface between veins bearing a variable number of fine appressed hairs. *Sori* inframedial; indusia small, glabrous or with a few glands; sporangia bearing glands.

Distr. *Malesia*: Philippines (Luzon, many collections), in forest at 700–1000 m.

Note. On Mt Makiling a large form of this species, above described, is common. On mountains further north are plants (including the type) with shorter abruptly pointed pinnae but closely similar in pubescence and in reduced pinnae to the plants on Mt Makiling. COPELAND placed most of the Mt Makiling plants in *Cyclosorus bordenii* (here included in *Sphaerostephanos heterocarpus*). He failed to notice the reduced basal pinnae of the type of *C. lobatus*. The plants here named *S. sessilipinna* and *S. urdanetensis* are very similar to the type of *S. lobatus* except in size of pinnae.

**66. *Sphaerostephanos ellipticus*** (ROSENST.) HOLTUM, *Kalikasan* 4 (1975) 66. — *Dryopteris elliptica* ROSENST. Meded. Rijksherb. Leiden n. 31 (1917) 6. — *Cyclosorus ellipticus* (ROSENST.) COPEL. Gen. Fil. (1947) 142; Fern Fl. Philip. (1960) 351, *nomen tantum*. — *Thelypteris elliptica*

(ROSENST.) REED, *Phytologia* 17 (1968) 274. — Type: ELMER 13976 *partim*, Mindanao, Mt Urdaneta (L, n. 914, 130–95; FI, G, K, U).

## KEY TO THE VARIETIES

1. Basal veins free on distal part of pinnae; lower surface of rachis hairy . . . **a. var. ellipticus**
1. Basal veins not free in distal part of pinnae; lower surface of rachis almost glabrous

**b. var. glabrior****a. var. ellipticus**

*Caudex* short, probably erect. *Stipe* 4–7 cm long, covered with very short hairs; base of stipe to first large pinna 35 cm. *Reduced pinnae* to 6 pairs, 3–4 cm apart, uppermost 3–5 mm long, lowest 2 mm or less. *Lamina* 45 cm long; pinnae to 18 pairs; basal pinnae slightly narrowed at base; aerophores hardly 1 mm long. Lower surface of *rachis* covered with very short hairs and rather sparse ones to 1 mm long; upper surface with uniform hairs 1 mm. *Largest pinnae* 8.5 × 1.6 cm, base truncate, apex short-acuminate, edges lobed 2/3 towards costa; costules 3.5 mm apart, at more than 60°; veins 8–9 pairs, basal pair near base of pinnae anastomosing with short excurrent vein to sinus, near apex of pinnae just meeting at the sinus-membrane; lower surface of costae hairy as rachis but longest hairs less than 1 mm, hairs on costules sparse, between veins very short erect hairs and glands; hairs on upper surface of costae 1 mm long, similar or shorter hairs scattered on costules and veins, short appressed hairs copious to rather sparse between veins. *Sori* inframedial; indusium firm with short stiff hairs; sporangia sometimes with glands.

Distr. *Malesia*: Philippines (Mindanao), only known from type.

Note. ELMER's n. 13976 included specimens of another species *S. norrisii*; COPELAND's description of 1960 applies to the latter.

**b. var. glabrior** HOLTUM, *var. nov.*

*A speciei typica differt: pinnis 3/5 costam versus lobatis; venis semper anastomosantibus; rachidi subtus fere glabra; costis subtus pilis 0.1–0.2 mm longis praeditis.* — Type: M. G. PRICE 2558, Negros Oriental, Amlan, near river, 600–800 m (K).

Distr. *Malesia*: Philippines (Negros Oriental), only known from the type.

**67. Sphaerostephanos foxworthyi** HOLTUM, *sp. nov.*

*S. elliptico* (Rosenst.) Holtum affinis, differt: pinnis redactis omnibus minutis; pinnis evolutis inferioribus basin versus valde angustatis. — Type: FOXWORTHY BS 2441, Luzon, Tayabas Prov. Mt Banajao (K).

*Caudex* short, creeping. *Stipe* 12 cm long,

glabrescent; scales broad and thin; base of stipe to first large pinna 36 cm. *Reduced pinnae* 5 pairs, each consisting of an aerophore without detectable blade. *Lamina* 50 cm long; pinnae c. 20 pairs; lowest 2 pairs much narrowed towards their bases; aerophores thick, to 1 mm long. *Rachis* bearing pale, erect hairs 0.2 mm long on lower surface, not dense. *Largest pinnae* 13 × 1.8 cm; base subtruncate; apex acuminate, sometimes with cauda 1–2 cm long; edges lobed 2/3–3/4 to costa; costules 4–4.5 mm apart, at 60°; veins 9 pairs, 1 pair anastomosing, next pair usually both to margin; lower surface of costae near base bearing erect hairs 0.1–0.2 mm long, distally hairs to 0.4 mm, antrorsely curved, not appressed, hairs on costules few, between veins many glands, not hairs; upper surface of costae bearing antrorse hairs less than 1 mm long, rest of surface covered with fine appressed hairs 0.2–0.3 mm long. *Sori* medial, lower ones divergent; indusia thin with glands and a few short hairs; sporangia bearing glands.

Distr. *Malesia*: Philippines (Luzon), only known from the type.

**68. Sphaerostephanos indrapuræ** HOLTUM, *sp. nov.*

*Pinnæ redactæ usque 10-jugatæ, superiores 3 mm longæ, aerophoris elongatis præditæ; pinnæ steriles usque 13 × 2.3 cm, fertiles 9 × 1.7 cm, c. 2/5 costam versus lobatæ; rachis subtus glabra, costæ costulaeque pilis appressis vestitæ; pagina inter venas glandulifera; pagina superior inter venas glabra; indusia glabra, sporangia glandulifera.* — Type: C. G. MATTHEW 655, Sumatra, G. Kerinci 1500 m (BO; K).

*Stipe* 10 cm long; base of stipe to first large pinna 50 cm. *Reduced pinnae* 10 pairs, blade of largest 3 mm long, with elongate aerophore. *Lamina* 50–60 cm long; pinnae c. 20 pairs, several lower pairs much narrowed towards their bases, only upper ones truncate to full width at base. *Rachis* glabrous on lower surface; hairs on upper surface slender, less than 1 mm long. *Largest pinnae* 13 × 2.3 cm (sterile), 9 × 1.7 cm (fertile), lobed c. 2/5 towards costa, lobes with blunt forward-pointing tips; apex abruptly short-acuminate; costules 5 mm (sterile) 4 mm (fertile) apart; veins 6–8 pairs, basal pair anastomosing, one or both of next pair ending at sinus-membrane; lower surface of costae and costules covered with fine closely appressed hairs 0.2–0.4 mm long, surface between veins bearing glands; hairs on upper surface of costae 0.5 mm long, sparse very short ones on costules, no others. *Sori* medial, lower ones a little divergent; indusia glabrous; sporangia bearing glands.

Distr. *Malesia*: Central Sumatra (Mt Kerinci), 1500 m, only known from the type.

**69. Sphaerostephanos batacorum** (ROSENST.)



HOLTUM, *comb. nov.* — *Dryopteris batacorom* ROSENST. Fedde Rep. 13 (1914) 217, *excl. var. winkleri*; v.A.v.R. Handb. Suppl. (1917) 185. — *Thelypteris batacorom* (ROSENST.) REED, Phytologia 17 (1968) 263. — Type: J. WINKLER 158, Sumatra, Batak Lands (S-PA).

*Dryopteris stipellata* var. *obtusata* v.A.v.R. Bull. Jard. Bot. Btztg III, 2 (1920) 151. — Syntypes: BROOKS 277, Sumatra, Lebong Tandai; 249, Tambang Sawah (BO; BM). — Fig. 13h-k.

*Caudex* short; erect (?). *Stipe* 5–10 cm long; base of stipe to first large pinna 30–50 cm. *Reduced pinnae* to 20 pairs, 1.5–2 cm apart, deflexed, largest 1.5–2 cm long, 8 mm wide, with acroscopic auricle 8 mm long, edges shallowly lobed, apex broadly obtuse. *Lamina* to 60 cm long; pinnae to 30 pairs, basal ones sometimes narrowed a little at base on basiscopical side; aerophores thick, to 2 mm long. *Rachis* beneath bearing short pale appressed or  $\pm$  spreading hairs 0.1–0.2 mm long, hairs on upper surface 1 mm long. *Largest pinnae*  $9 \times 1.6$  cm; base truncate; apex abruptly short-pointed; edges lobed 1/3–2/5 to costa; costules 3–3.5 mm apart; veins to 8 pairs, basal pair anastomosing, one or both of next pair to sinus-membrane; hairs on lower surface of costa and costules pale, closely appressed, 0.2–0.3 mm long; surface between veins bearing glands which in some specimens are sparse (most abundant on reduced pinnae); hairs on upper surface of costae less than 1 mm long, sometimes no long hairs on costules, rest of upper surface glabrous. *Sori* medial; indusia rather large, glabrous, sometimes with a few glands; sporangia sometimes with a gland.

Distr. *Malesia*: Sumatra, several collections, at 850–1000 m.

Note. The type is a small specimen; the above description is prepared partly from larger specimens collected on G. Singgalang and G. Kerinci which agree in shape and pubescence of frond and of reduced pinnae.

**70. *Sphaerostephanos angustibasis* HOLTUM, sp. nov.**

*Caudex erectus, gracilis; pinnae redactae 6-jugatae, superiores 5 mm longae, auriculatae; aerophora elongata; pinnae usque  $9.5 \times 2.1$  cm, inferiores basi angustatae, 2/3 costam versus lobatae; costae subtus patenti-pilosae; pagina inter venas subtus glandulosa; indusia sporangiaque glandulifera.* — Type: ALSTON 16724, Tidore, G. Kiematuba (BM).

*Caudex* slender, to 20 cm tall. *Stipe* 15 cm long, short-hairy; base of stipe to first large pinna 60 cm. *Reduced pinnae* c. 6 pairs, subopposite, upper ones 5 mm long, deflexed, narrow, with basal acroscopic auricle 4 mm long. *Lamina* 38 cm long; pinnae to 15 pairs, almost all opposite, lower 3–4 pairs narrowed towards their bases, basal pair 5–7 mm wide at base; aerophores 1 mm long.

Lower surface of *rachis* bearing curved brown hairs and very short ones, brown hairs on upper surface more uniform. *Largest pinnae*  $9 \times 2.1$  cm, base truncate, apex short-acuminate, edges lobed up to 2/3 towards costa, lobes slightly falcate; costules 5 mm apart, at more than  $60^\circ$ ; veins 7–8 pairs, all at a wide angle to costule, pale and prominent both sides, basal pair anastomosing, next pair both to edge; most hairs on lower surface of costae minute, with some longer, erect, on costules all short, glands present throughout lower surface; upper surface of costae covered with brown hairs, similar hairs scattered on costules and veins, surface between veins glabrous. *Sori* medial; indusia small, with glands and a few hairs; sporangia with many glands, sometimes also with a seta; spores with many small wings.

Distr. *Malesia*: Moluccas (Tidore), only known from the type.

**71. *Sphaerostephanos nudisorus* HOLTUM, sp. nov.**

*Pinnae redactae 12-jugatae, superiores 3 mm longae; aerophora 2 mm longa; pinnae normales usque  $15 \times 1.8$  cm, profunde lobatae; rachis subtus glabra, costae subtus pilis minutis erectis praeditae; pagina inter venas subtus glandulifera, supra glabra; sori mediales, exindusiati; sporangia nec glandulis nec setis praedita.* — Type: T. G. WALKER 12269, Central Celebes (BM).

*Caudex* not known. *Stipe* 5 cm long, glabrous; base of stipe to first large pinna 50 cm. *Reduced pinnae* c. 12 pairs, upper ones 3 mm long, with aerophores 2 mm long. *Lamina* 95 cm long; pinnae c. 40 pairs, lowest not narrowed at base; one pair of intermediate length between normal and reduced pinnae. Lower surface of *rachis* bearing glands and small scales only, upper surface covered with hairs 1 mm long. *Largest pinnae*  $15 \times 1.8$  cm; base truncate with basal acroscopic lobe 2 mm longer than next; apex acuminate with cauda 1.5–2 cm long; edges lobed to 2 mm from costa, lobes oblong, hardly falcate, with rounded ends; costules 4 mm apart, at more than  $60^\circ$ ; veins 8 pairs, basal pair anastomosing near base of pinna, near apex just meeting at the sinus; hairs on lower surface of costae very short, erect, glands abundant all over lower surface; hairs on upper surface of costae 1 mm long, similar hairs scattered on costules and veins, rest of upper surface glabrous. *Sori* medial, exindusiate; neither glands nor setae on sporangia; spores minutely spinulose.

Distr. *Malesia*: Central Celebes, only known from the type.

**72. *Sphaerostephanos paripinnatus* (COPEL.) HOLTUM, *comb. nov.* — *Dryopteris paripinnata* COPEL. Univ. Cal. Publ. Bot. 18 (1942) 220. — *Cyclosorus paripinnatus* (COPEL.) COPEL. Gen. Fil. (1947) 143; Philip. J. Sci. 78 (1951) 448, pl.**



28. — *Thelypteris paripinnata* (COPEL.) REED, *Phytologia* 17 (1968) 302. — Type: BRASS 12435, New Guinea, Idenburg River (MICH; BO, L).

*Caudex* probably erect. *Stipe* 10 cm long, glabrous, basal scales narrow; base of stipe to first large pinna 60 cm. *Reduced pinnae* to 10 pairs, each consisting of an aerophore 2 mm long and a minute blade; transition to normal pinnae abrupt. *Lamina* to 75 cm long; apical section long and deeply lobed with gradual transition to pinnae; pinnae 20 pairs, their ends much upcurved, subcoriaceous. *Largest pinnae* 21 × 2.5 cm; base truncate to subcordate, apical 3–5 cm gradually attenuate and crenate, middle part lobed more than  $\frac{1}{2}$  way to costa, lobes somewhat narrowed, not falcate; costules to 6 mm apart, almost at right angles to costa; veins 11–12 pairs, at a very wide angle to costule, basal pair anastomosing, next pair both to sides of short sinus-membrane; lower surface of rachis, costae and costules with spreading hairs 0.4 mm long, shorter erect hairs and glands between veins; hairs on upper surface of costa 1 mm long, similar hairs scattered on costules and veins, no hairs nor glands between veins. *Sori* medial, basal ones divergent; no indusia; sporangia lacking hairs and glands on body, hairs on stalk with yellow gland, often 2; spores not seen.

*Distr. Malesia:* W. New Guinea. Only known from the type.

*Ecol.* At 1700 m, "a large clump-fern common in rain-forest gullies".

**73. *Sphaerostephanos novae-britanniae* HOLTUM, sp. nov.**

*Caudex erectus*; *pinnae redactae* 7-jugatae, superiores 7 mm longae; *pinnae normales oppositae*, usque 8 × 1.2 cm, 2/3 costam versus lobatae; *venae infimae raro anastomosantes*; *costae subtus pilis erectis praeditae*; *pagina inter venas subtus glandulifera*, supra pilis brevibus suberectis praedita; *indusia brevi-pilosa*, *sporangia glandulifera*. — Type: STEVENS & LELAND LAE 58644, New Britain. Subdistr. Pomio, 890 m (K).

*Caudex* erect, to 15 cm tall. *Stipe* 4 cm long, scales at base thin, 8 × 1 mm, closely setiferous; base of stipe to first large pinna 27 cm. *Reduced pinnae* 3 cm apart, c. 7 pairs, uppermost 7 mm long, 5 mm wide at slightly asymmetric base, edges lobed, apex acute. *Lamina* 40 cm long; pinnae 22 pairs, almost all opposite, basal ones with 3 basal lobes gradually smaller, base 6 mm wide, not auricled; aerophores not elongate. Hairs on lower surface of rachis 0.3–0.4 mm long, erect, on upper surface more than 0.5 mm long. *Largest pinnae* 8 × 1.2 cm; base broadly cuneate, apex acuminate with cauda 10 × 2 mm; edges lobed 2/3 to costa; costules 2.5 mm apart, at 60°; veins to 7 pairs, basal veins either meeting just below the short sinus-membrane or touching its sides, rarely joining to form an excurrent vein below the sinus;

hairs on lower surface of costae as rachis, few on costules, surface between veins densely glandular with some short erect hairs; hairs on upper surface of costae pale, more than 0.5 mm long, similar hairs scattered on costules and veins, surface between veins bearing suberect hairs 0.2 mm long and sometimes a few glands. *Sori* inframedial, basal ones not divergent; indusia large, firm, short-hairy; sporangia sometimes bearing glands.

*Distr. Malesia:* New Guinea (New Britain), only known from the type.

**74. *Sphaerostephanos convergens* HOLTUM, sp. nov.**

*Pinnae redactae* 4–5-jugatae, omnes parvae; *aerophora non elongata*; *pinnae usque* 6.5 × 1.3 cm, 3/5 costam versus lobatae; *venae infimae conniventes, non anastomosantes*; *costae subtus pilis erectis usque 1 mm longis praeditae*; *pagina inter venas utrinque pilis brevibus erectis praedita*, subtus etiam glandulifera; *indusia pilosa*; *sporangia glandulifera*. — Type: M. G. PRICE & B. F. HERNAEZ 164, Western Samar, 500 m (K).

*Caudex* short, suberect, bearing a close tuft of fronds. *Stipe* 4 cm long; basal scales 7 × 0.8 mm, thin; base of stipe to first large pinna 20 cm. *Reduced pinnae* 4–5 pairs, uppermost 2 mm long; aerophores swollen, hardly elongate. *Lamina* 28 cm long; pinnae 10–12 pairs, lowest 1–2 pairs somewhat narrowed at their bases. Hairs on lower surface of rachis erect, pale, 0.3 mm long, with some more than 1 mm long also; hairs on upper surface more than 1 mm long. *Largest pinnae* 6.5 × 1.3 cm; base truncate; apex short-acuminate; edges lobed c. 3/5 to costa, lobes slightly falcate, separated by sinuses nearly 1 mm wide; costules 4 mm apart, at 60°; veins to 6 pairs, basal pair both touching sides of short sinus-membrane or meeting just below it without fusing, next pair to edge; hairs on lower surface of costae and costules erect, as on rachis but shorter, surface between veins bearing many short erect hairs and glands; hairs on upper surface of costae 1 mm long, similar hairs scattered on costules and veins, surface between veins bearing suberect hairs 0.2 mm long. *Sori* inframedial, basal ones not divergent; indusia bearing hairs 0.4 mm long; sporangia bearing glands.

*Distr. Malesia:* Philippines (W. Samar), only known from the type.

*Ecol.* In forest on limestone soils.

**75. *Sphaerostephanos unitus* (L.) HOLTUM, J. S.** *Afr. Bot.* 40 (1974) 165; *Kalikasan* 4 (1975) 63. — *Polypodium unitum* L. *Syst. Nat.* ed. 10. 2 (1759) 1326, excl. syn. — *Aspidium unitum* (L.) Sw. in Schrad. *J. Bot.* 1800, 2 (1801) 32, *nomen tantum*; *WILLD. Sp. Pl.* ed. 4, 5 (1810) 241. — *Dryopteris unita* (L.) O. Ktze, *Rev. Gen. Pl.* 2 (1891) 811; *BACKER & POSTH. Varenfl. Java* (1939) 51. —

*Cyclosorus unitus* (L.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 8 (1938) 192; HOLTUM, Rev. Fl. Mal. 2 (1955) 260, f. 147; COPEL. Fern Fl. Philip. (1960) 360. — *Thelypteris unita* (L.) MORTON, Amer. Fern J. 49 (1959) 113. — Type: without locality (LINN).

*Tectaria serrata* CAV. Descr. (1802) 251; C. CHR. Dansk Bot. Ark. 9, n. 3 (1937) 16, t. 1, f. 10–11. — *Nephrodium serratum* (CAV.) PRESL, Rel. Haenk. (1825) 34. — Type: NÉE, Marianas (MA).

*Nephrodium insculptum* DESV. Mém. Soc. Linn. Paris 6 (1827) 254. — Type: Réunion, no collector named (P).

*Aspidium cucullatum* BL. En. Pl. Jav. (1828) 151. — *Nephrodium cucullatum* (BL.) BAK. Syn. Fil. (1867) 290; BEDD. Handb. (1883) 270; RACIB. Fl. Btzig I (1898) 184. — *Dryopteris cucullata* (BL.) CHRIST, Philip. J. Sci. 2 (1907) Bot. 194; v.A.v.R. Handb. (1908) 213. — Type: BLUME, Java (L, n. 908, 337–5).

*Nephrodium haenkeanum* PRESL, Epim. Bot. (1851) 46; HOLTUM, Novit. Bot. Univ. Carol. Prag. 1968 (1969) 17. — *Thelypteris haenkeana* (PRESL) REED, Phytologia 17 (1968) 281. — Type: HAENKE, Marianas (PRC).

#### KEY TO THE VARIETIES

1. Glands present on some part of lower surface of pinnae.
2. Rather large glossy brownish glands present on and between veins on lower surface
  - a. var. **unitus**
  2. Smaller dull yellow glands present on costules and veins only . . . . . b. var. **mucronatus**
1. Glands lacking on lower surface; cells between veins all papilliform . . . c. var. **papilliferus**

#### a. var. **unitus**

*Rhizome* long-creeping, commonly to 5 mm diameter; *stipe* 10–20 cm long, base of stipe to first normal pinna 30–60 cm; *reduced pinnae* 6–12 pairs, lower ones very small, upper ones triangular with symmetric base, to 10 mm long. *Lamina* 30–60 cm long; pinnae closely placed, lowest not or little narrowed at base, aerophores not elongate. Hairs on both sides of *rachis* less than 1 mm long. *Largest pinnae* 10–15 × 0.8–1.5 cm; base broadly cuneate; apex rather evenly attenuate; edges lobed 1/3 towards costa; lobes rounded with a slight point at falcate end of costule; costules 3–4 mm apart; veins 8–10 pairs, 1½ pairs anastomosing, next 2–4 pairs passing to sides of sinus-membrane which forms a ridge on the lower surface; hairs on lower surface of costae c. 0.5 mm long, slender, always antrorse but not closely appressed, similar hairs on costules; rather large brownish glossy glands present on costules and veins, and between veins; *upper surface* of pinnae hairy on costae only. *Sori* supramedial; indusia

firm, glabrous or with a few short hairs, sometimes also glands; sporangia bearing glands near annulus, also copious glands at the ends of hairs on sporangium-stalks.

Distr. E. Africa; Mascarene Islands; Ceylon & S. India; N.E. India, Burma & Thailand (few specimens); *Malesia* (Malaya, Sumatra, Java, S.W. Celebes, Lesser Sunda Is., few specimens from Luzon and Mindanao, 1 from W. New Guinea); Guam, N. Queensland.

Ecol. At low altitudes, in open places, in moist (not swampy) ground.

Notes. The identity of this species is fixed by the type. LINNAEUS's description is not adequate, and his references to plants from Asia all indicate the species here named *Cyclosorus interruptus* (WILLD.) CHING. ROBERT BROWN and others interpreted *Polypodium unitum* according to the references, and BEDDOME followed this usage. It is now customary to accept the type as fixing the application of a name in such cases; it is to be noted that the specimen in the Willdenow Herbarium agrees with the Linnaean type.

The next name, *Tectaria serrata* CAV., was based on a specimen collected by NÉE in Guam. Specimens of the same species were also collected there by HAENKE, and PRESL at first (1825) identified them with *T. serrata*, but later (1851) thought this was wrong and published the new name *Nephrodium haenkeanum* for them. There is no doubt that the two collections were identical.

b. var. **mucronatus** (CHRIST) HOLTUM, *comb. nov.* — *Dryopteris cucullata* var. *mucronata* CHRIST, Philip. J. Sci. 2 (1907) Bot. 195; v.A.v.R. Handb. (1908) 819. — Type: CUMING 182, Luzon (CHRIST's specimen not seen; isotypes FI-W, K, LE).

*Aspidium multilineatum* METT. Farngett. IV (1858) 108. — Syntypes: CUMING 182, 278, Luzon (duplicates of 278 at FI-W, G, K, LE, PRC).

*Nephrodium haenkeanum sensu* BAK. Syn. Fil. (1867) 290.

Pinnae 15–20 × 1.0–2.0 cm; veins 10–14 pairs; glands present only on costules and veins of lower surface, small, dull, yellow; indusia always hairy.

Distr. Polynesia (Samoa, Fiji, Tonga), Micronesia (Palau), and *Malesia*: New Guinea, Moluccas, Lesser Sunda Is. (Sumba, Wetar, Timor), Celebes, Philippines and Borneo.

Notes. The characteristic glands on the lower surface of costules and veins were described by METTENIUS but ignored by all others. METTENIUS however made a confusion by adopting the name *multilineatum* from WALLICH and citing WALLICH 353 from Penang, which represents the species here named *S. penniger*, very different from the CUMING specimens which were clearly the basis of METTENIUS's description. BEDDOME later adopted the WALLICH epithet for *S. penniger*.

BAKER wrongly referred CUMING 182 to *Nephrodium haenkeanum*. FOURNIER also adopted this name in his work on the ferns of New Caledonia, but his citation of specimens shows that he confused it with other species. The New Caledonia specimens which he so named are *S. invisus*.

The varietal name *mucronatus* was first published by J. SMITH in 1843, as a *nomen nudum* under which he cited specimens of three species; it was not validated until CHRIST's description of 1907. Both *var. unitus* and *var. mucronatus* occur in the Lesser Sunda Islands; they may occupy different habitats; records are inadequate.

c. *var. papilliferus* HOLTUM, *var. nov.*

A *typo speciei differt: costulis venisque subtus eglandulosis; pagina subtus inter venas omnino minute papillifera*.—Type: HOOGLAND 9084, N.E. New Guinea, Huon Peninsula, 1320 m (K).

Distr. *Malesia*: New Guinea, many specimens, at 1300–2000 m.

Note. All cells on the lower surface of pinnae have small papilliform colourless outgrowths. Stomata presumably occur, but they are not detectable. The condition is probably an adaptation to extreme exposure.

**76. *Sphaerostephanos sessilipinna*** (COPEL.) HOLTUM, *Kalikasan* 4 (1975) 53. — *Dryopteris sessilipinna* COPEL. *Philip. J. Sci.* 6 (1911) Bot. 145. — *Cyclosorus sessilipinna* (COPEL.) CHING, *Bull. Fan Mem. Inst. Biol. Bot.* 10 (1941) 249; COPEL. *Fern Fl. Philip.* (1960) 353. — *Thelypteris sessilipinna* REED, *Phytologia* 17 (1968) 313. — Type: MERRILL 6934, Negros, Mt Canlaon (MICH).

*Dryopteris canlaonensis* COPEL. *Philip. J. Sci.* 40 (1929) 300. — *Thelypteris canlaonensis* (COPEL.) REED, *Phytologia* 17 (1968) 266. — Type: MERRILL 6934, Negros (MICH).

*Dryopteris austrophilippina* COPEL. *Philip. J. Sci.* 40 (1929) 300. — *Cyclosorus austrophilippinus* (COPEL.) COPEL. *Gen. Fil.* (1947) 142; *Fern Fl. Philip.* (1960) 354. — *Thelypteris austrophilippina* (COPEL.) REED, *Phytologia* 17 (1968) 262. — Type: COPELAND 1705, Mindanao, San Ramon (MICH).

*Caudex* short, creeping. *Stipe* 5 cm long; base of stipe to first large pinna 15–20 cm. *Reduced pinnae* 4–6 pairs, all less than 2 mm long. *Lamina* to 20 cm long; apical section 10–12 cm long, deeply lobed, tapering very gradually to tip, at base with gradual transition to pinnae; free pinnae 10–12 pairs, very close; basal pinnae deflexed and narrowed towards their bases; aerophores not elongate. *Rachis* with thick curved brown hairs both sides. *Middle pinnae* 2.3 × 0.8 cm, lobed about 1/3 to costa, apex obtuse; costules 2 mm apart; veins 2–4 pairs, basal pair anastomosing in basal half of pinna, free near its tip; hairs on lower

surface of costae pale, antrorsely curved; glands present on surface between veins; *upper surface* of type bearing rather sparse appressed hairs between veins, of other specimens many. *Sori* medial or inframedial; indusia glabrous or with a few short hairs; sporangia bearing glands.

Distr. *Malesia*: Philippines (Negros, Mindanao).

Notes. The type of *D. austrophilippina* has a less tapering apical lamina than the other type, and paler hairs on lower surface of rachis. In 1975 I included *D. urdanetensis* COPEL. also as a synonym of the present species, but it lacks very small basal reduced pinnae. Apart from size, there is little to distinguish this from *S. lobatus*.

**77. *Sphaerostephanos lobangensis*** (C. CHR.) HOLTUM, *comb. nov.* — *Dryopteris lobangensis* C. CHR. *Gard. Bull. Str. Settl.* 7 (1934) 245. — *Thelypteris lobangensis* (C. CHR.) REED, *Phytologia* 17 (1968) 289. — Type: CLEMENS 10728, Mt Kinabalu, Pakka Cave to Lobang (MICH; BO).

*Caudex* short, suberect. *Stipe* 12 cm long; base of stipe to first large pinna 50 cm. *Reduced pinnae* 10 pairs, upper ones 3 mm long. *Lamina* to 40 cm long; pinnae to 20 pairs; basal pinnae a little reduced and deflexed, narrowed towards their bases; aerophores not elongate. Lower surface of *rachis* glabrous. *Largest pinnae* 6 × 1.4 cm; base truncate; apex short-acuminate; edges lobed 1/3 to costa; costules 3 mm apart, at 60°; veins to 6 pairs, 1 pair anastomosing, next acroscopic vein to side of sinus-membrane; *lower surface* of pinnae quite glabrous, with yellow glands throughout; hairs on *upper surface* of costae short, on costules shorter, few on veins, no others. *Sori* inframedial, basal ones not divergent; indusia small, glandular; sporangia bearing glands.

Distr. *Malesia*: Sabah (Mt Kinabalu), in forest at 1500–2000 m; two collections, the second being an unnumbered CLEMENS specimen from Marei Parei spur "on rocks in stream" (BO).

Notes. The above description is prepared from the Bogor isotype; the type at MICH is somewhat smaller. CHRISTENSEN described the rhizome as creeping with widely-spaced stipes, but this is not true of the Bogor specimen.

**78. *Sphaerostephanos gymnorachis*** HOLTUM, *sp. nov.*

*Caudex erectus; pinnae redactae usque 8–10-jugatae, superiores 3 mm longae; pinnae normales fertiles usque 16 × 1.9 cm, 1/2–5/8 costam versus lobatae; rachis subtus glabra, costae costulaeque pilis brevibus antrorsis vestitae, pagina inter venas glandulosa; indusia glabra; sporangia glandulifera*.—Type: HOLTUM 34, Mt Kinabalu, Pinosok area, Nov. 1972 (K).

*Caudex* erect, at least to 10 cm tall. *Stipe* 10 cm long, dull reddish; base of stipe to first large pinna

of largest fronds 50 cm. *Reduced pinnae* 4–5 cm apart, 8–10 pairs, uppermost 3 mm long, lowest with no evident blade. *Lamina* to 70 cm long; pinnae more than 20 pairs, in most cases all opposite; basal pinnae gradually narrowed towards base in basal 4 cm, next 2–3 pairs less narrowed; aerophores not elongate. Lower surface of *rachis* glabrous; hairs on upper surface 0.5 mm long, brown. *Largest fertile pinnae* 16 × 1.9 cm (sterile to 2.3 cm wide); base broadly cuneate; apex acuminate with cauda 1–1.5 cm; edges lobed a little more than  $\frac{1}{2}$  way to costa (about  $\frac{1}{2}$  way on upper pinnae or those of small fronds); lobes falcate, distinctly tapered to a blunt tip; costules 3.5–4 mm apart (to 5 mm in sterile fronds); veins to 12 pairs, basal pair anastomosing with long excurrent vein to sinus, second pair both to sides of sinus-membrane; lower surface of costae near base covered with hairs 0.1–0.2 mm long, near apex 0.3–0.4 mm, antrorse but not closely appressed, on costules similar, sparser and shorter on veins, many glands on surface between veins (hairs on lower surface of sterile pinnae somewhat longer, distal ones on costae 0.5 mm); hairs on upper surface of costae brown, 0.7 mm long, on costules 0.2 mm, pale, rarely with a solitary longer hair; surface between veins glabrous or with a few pale appressed hairs. *Sori* medial, basal ones somewhat divergent; indusia large, glabrous; sporangia bearing glands.

Distr. *Malesia*: Sabah (Mt Kinabalu), in forest at 1500 m.

Notes. In addition to the type collection, CLEMENS 28233 and 28382 (from Tenompok, 1500 m) have pinnae not opposite and upper surface between veins covered with many appressed hairs; CLEMENS 29050 (Silau Basin, 2100 m) is a smaller plant (pinnae to 9 × 1.5 cm) with almost sterile fronds, differing in scattered pale hairs 1 mm long on lower surface of rachis. *S. gymnorachis* may be a fully developed form of *S. lobangensis*.

**79. *Sphaerostephanos pullenii* HOLTUM, sp. nov.**

*Pinnae redactae* 6-jugatae vel ultra, omnes parvae; *pinnae normales* 26 × 3.0 cm, 3/4–4/5 costam versus lobatae; *rachis costaeque subtus glabra vel pilis minutis paucis praedita*; *pagina subtus inter venas glandulosa, supra pilis erectis brevibus praedita*; *indusia parva, glandulifera, sporangia nec glandulis nec setis instructa*. — Type: R. PULLEN 672, N.E. New Guinea, Eastern Highlands (BM; L, LAE).

*Caudex* erect. *Stipe* 30 cm long, glandular; base of stipe to first long pinna 85 cm. *Reduced pinnae* 6 cm apart, at least 6 pairs, all very small. *Lamina* 85 cm or more long; pinnae to 30 pairs; basal pinnae narrowed towards their bases, basal lobes 6–10 mm long; aerophores not elongate. Lower surface of *rachis* glabrous or with sparse minute erect hairs; upper surface with pale hairs less than

1 mm long. *Largest pinnae* 26 × 2.0 cm; base truncate; apex caudate-acuminate (cauda to 3 cm); edges lobed to 3–3.5 mm from costa, lobes slightly falcate; costules 5–7 mm apart, at more than 60°; veins to 12 pairs, basal pair at a wide angle to costule meeting to form a long excurrent vein, one or both of next pair passing to sinus-membrane; lower surface of costae near base with sparse minute hairs, somewhat longer hairs distally, costules similar; copious glands between veins; hairs on upper surface of costae 0.5 mm long, shorter on costules with a few long ones near apices of lobes, surface between veins bearing very short suberect hairs. *Sori* medial, lower ones divergent, lowest somewhat elongate; indusia small, thin, with marginal glands; sporangia bearing neither glands nor setae.

Distr. *Malesia*: Papua New Guinea.

Ecol. In *Nothofagus* forest at 2000 m.

**80. *Sphaerostephanos gregarius* (COPEL.) HOLTUM, comb. nov. — *Cyclosorus gregarius* COPEL. J. Arn. Arb. 24 (1943) 440; Philip. J. Sci. 78 (1951) 451, pl. 31. — *Thelypteris gregaria* (COPEL.) REED, Phytologia 17 (1968) 280. — Type: BRASS 6759, Papua, Fly River (MICH; BM, BO, L).**

*Caudex* short; erect or suberect. *Stipe* 25–30 cm long, dull reddish; base of stipe to first large pinna 60 cm. *Reduced pinnae* 7 pairs, lowest 3–4 mm long, uppermost 2.2 cm long, broadly triangular, subentire, base slightly asymmetric. *Lamina* 60 cm long; apex on type pinna-like, on isotype at L not pinna-like; pinnae 16 pairs, lower ones 4 cm apart, subopposite, not narrowed towards their bases, upper ones close and alternate; aerophores not elongate. *Rachis* glabrous on lower surface or with minute appressed hairs; hairs on upper surface not over 1 mm long. *Largest pinnae* 15 × 1.5 cm; base subequally broadly cuneate and a little dilated both sides; apex acuminate; edges lobed to a depth of 2–2.5 mm (on BM and BO isotypes little more than 1 mm); costules 3.5–4 mm apart, at 60° or more; veins 6–7 pairs, 2–3 pairs anastomosing, 1 pair to short sinus-membrane; lower surface of costa glabrous or with minute appressed hairs, no other hairs on lower surface, sparse glands present on costules and on surface between veins; hairs on upper surface of costae 1 mm long, rest of upper surface glabrous apart from short hairs on margin. *Sori* medial or inframedial, lowest not divergent; indusia very small, thin, bearing a few very short hairs; sporangia bearing glands.

Distr. *Malesia*: Eastern New Guinea, at altitudes to 1000 m, in forest.

**81. *Sphaerostephanos tephrophyllus* (COPEL.) HOLTUM, Kalikasan 4 (1975) 58. — *Dryopteris tephrophylla* COPEL. Philip. J. Sci. 40 (1929) 296. — *Cyclosorus tephrophyllus* (COPEL.) COPEL. Gen. Fil. (1947) 143; Fern Fl. Philip.**

(1960) 350. — *Thelypteris tephrophylla* (COPEL.) REED, *Phytologia* 17 (1968) 319. — Type: COPELAND s.n. 18 April 1905, Mindanao, Zamboanga, San Ramon (MICH).

*Caudex* suberect, short. *Stipe* 3–4 cm long; base of stipe to first large pinna 12–15 cm. *Reduced pinnae* 3–5 pairs, lowest 3–5 mm long, uppermost to 1.5 × 0.8 cm, entire, deflexed, auricled on acroscopic base; transition to normal pinnae not abrupt. *Lamina* to 25 cm long; apical section to 12 cm, deeply lobed and grading to upper pinnae; free pinnae 5–6 pairs, lower ones slightly reduced and sometimes a little auricled on acroscopic base; aerophores not elongate. Hairs on lower surface of *rachis* short, with sparse longer ones, on upper surface similar but thicker, the long ones more than 1 mm. *Largest pinnae* 4.5 × 1.4 cm (sterile), 3.5 × 1.2 cm (fertile); base truncate; apex short-pointed; edges crenate to a depth of less than 1 mm; costules 3–3.5 mm apart; veins to 4 pairs, 1 pair anastomosing, next pair to sides of sinus-membrane; hairs on lower surface of costae and costules short, with a few longer ones, between veins short hairs and glands; short hairs on upper surface of costae, between veins very short suberect hairs. *Sori* medial; indusia large, with a few hairs; sporangia sometimes with a gland.

*Distr. Malesia*: Philippines (Mindanao), 3 collections.

*Note*. Allied to *S. spenceri*, differing in little but much smaller size.

**82. *Sphaerostephanos pilososquamatus*** (v.A.v.R.) HOLTTUM, *comb. nov.* — *Dryopteris pilososquamata* v.A.v.R. Bull. Dép. Agr. Ind. Néerl. 21 (1908) 4; Handb. (1908) 222; Handb. Suppl. (1917) 181, excl. var. *obtusata*. — *Thelypteris pilososquamata* (v.A.v.R.) REED, *Phytologia* 17 (1968) 304. — Type: cult. Hort. Bog., origin W. New Guinea (BO; BM, L).

*Dryopteris paraphysata* COPEL. Philip. J. Sci. 6 (1911) Bot. 74. — *Thelypteris paraphysata* REED, *Phytologia* 17 (1968) 301. — Type: C. KING 306, Papua (MICH; NSW, P).

*Dryopteris megaphylloides* ROSENST. Fedde Repert. 12 (1913) 174. — *Thelypteris megaphylloides* (ROSENST.) REED, *Phytologia* 17 (1968) 292. — Type: KEYSSER 120, N.E. New Guinea, Sattelberg (orig.?; UC). — Fig. 12i–k.

*Caudex* short, creeping. *Stipe* on a well-grown plant 30–40 cm long; base of stipe to first large pinna 45–55 cm (sterile) 60–70 cm (fertile). *Reduced pinnae* 2–3(–4) pairs, largest 5 mm long; an intermediate pair sometimes present. *Lamina* dimorphous; pinnae to 15 pairs, sometimes with stalks 1–2 mm long; basal pinnae narrowed towards their bases; apical lamina almost pinna-like; aerophores not elongate. Hairs on *rachis* of sterile fronds to 1 mm long both sides, rather sparse on lower surface. *Largest sterile pinnae*

20–27 × 3.5–4 cm; base broadly cuneate; apex acuminate with cauda to 2 cm; edges lobed 1/4–2/5 to costa, lobes falcate, narrowed to tips in more deeply lobed pinnae; costules 5–5.5 mm apart, at 60° or rather less; veins 12–15 pairs, 2–3 pairs anastomosing, 2–3 pairs to sides of sinus-membrane; hairs on lower surface of costae spreading, 0.5–1 mm long, not dense, on costules and veins similar but fewer, glands usually present on costules and veins and between veins, not abundant; scattered hairs on upper surface of costules and veins like those on costae, appressed hairs between veins sometimes present. *Fertile pinnae* commonly to 18 × 2 cm, less deeply lobed than sterile and with closer costules, hairs on all parts shorter and more sparse; veins 7–9 pairs; *sori* medial, lower ones not or little divergent; indusia bearing glands and hairs; sporangia usually with a seta, sometimes also a gland, near annulus, and a gland at end of hair on stalk.

*Distr. Malesia*: New Guinea, Bismarck Archipelago, in forest, 0–1400 m.

*Note*. One specimen assigned to this species appears to be quite eglandular. Another (NAKAIKE 73) is small, lacks reduced pinnae and has no glands on sporangia.

**83. *Sphaerostephanos angustifolius*** (PRESL) HOLTTUM, *Kalikasan* 4 (1975) 66. — *Nephrodium angustifolium* PRESL, *Epim. Bot.* (1851) 48; HOOK. Spec. Fil. 4 (1862) 69. — *Cyclosorus angustifolius* (PRESL) COPEL. Fern Fl. Philip. (1960) 349. — *Thelypteris setulosa* REED, *Phytologia* 17 (1968) 313, *nom. nov.* — Type: CUMING 268, Luzon (PRC; B, BM, E, FI-W, G, K, LE, US). *Dryopteris hispidula* sensu C. CHR. Ind. Fil. (1905) 271, p.p.; v.A.v.R. Handb. (1908) 228.

*Caudex* short, erect. *Stipe* 4–6 cm long, dark reddish, densely short-hairy; base of stipe to first large pinna 15 cm or more. *Reduced pinnae* to 5 pairs, highest 3 mm long. *Lamina* to 35 cm long; pinnae c. 17 pairs; lower 2–3 pairs somewhat narrowed towards their bases with basal acroscopic lobe a little elongate; aerophores not elongate. Lower surface of *rachis* covered with short erect hairs and scattered longer ones (some of them dark red), upper surface covered with pale hairs 0.5 mm long. *Largest pinnae* 9.5 × 0.8 cm; base truncate and not dilated; apex a subentire cauda 1.5–2.0 cm long; edges lobed 1/2 way to costa, lobes oblique; costules 3 mm apart, at 60°; veins 4–5 pairs, 1 pair anastomosing, next pair to margin; hairs on lower surface of costae not dense, very short, with scattered hairs to 0.8 mm long, on costules similar but more sparse, minute erect hairs present between veins, glands throughout lower surfaces; hairs on upper surface of costae 0.5 mm long, similar hairs scattered on costules and veins, suberect hairs 0.1–0.2 mm long between veins. *Sori* medial; indusia short-hairy; sporangia bearing glands.

Distr. *Malesia*: Philippines (Luzon); a second collection is M. G. PRICE 2553, Zambales Prov., from exposed place by stream (small plants).

Note. *S. angustifolius* is very near *S. heterocarpus*; it is peculiar in its very narrow pinnae.

**84. *Sphaerostephanos efogensis* HOLTUM, sp. nov.**

*S. conferto* (Brause) *affinis*, differt: *membranis sinuum brevibus*; *costis subtus pilis usque 1 mm longis vestitis*; *costulis subtus glanduliferis*; *soris supramedialibus, sporangiis glanduliferis*. — Type: J. R. CROFT LAE 61873, Papua, Central Distr., Port Moresby Subdistr. Efogi (K).

*Caudex* short, decumbent (collector). *Stipe* 12–20 cm long, basal scales short and thick, apparently 1.5 × 1 mm; base of stipe to first large pinna 40–60 cm. *Reduced pinnae* 12 pairs, lowest 2–4 mm long, middle ones 10 × 10 mm, uppermost 1.7 cm long, 1.3 cm wide at truncate base, triangular, crenate. *Lamina* 43 cm long; apex broadly deltoid and deeply lobed; pinnae 20 pairs, basal ones not narrowed at base; aerophores not elongate. Hairs on lower surface of *rachis* not dense, mostly 0.1–0.3 mm long with some more than 1 mm, on upper surface long hairs more numerous, to 1.5 mm long. *Largest pinnae* 8.5 × 1.7 cm; base subtruncate, almost symmetric; apex short-acuminate; edges lobed to a depth of 2 mm, lobes oblique, subtriangular; costules to 3.5 mm apart; veins 7–8 pairs, all except basal ones very oblique, 2–2½ pairs anastomosing to form a zig-zag excurrent vein, 1 pair to short sinus-membrane; hairs on lower surface of costae as on rachis, on costules shorter, glands present on costules and veins, between veins sparse short erect hairs and sometimes a few glands; hairs on upper surface of costae mostly 0.3 mm long with scattered long ones which occur also on costules and veins, surface between veins bearing appressed hairs 0.2–0.3 mm long. *Sori* a little supramedial; indusia thin, with a few hairs 0.5 mm long; sporangia bearing glands.

Distr. *Malesia*: Papua New Guinea.

Ecol. At 1500 m in riverine hill forest.

**85. *Sphaerostephanos dichrotrichoides* (v.A.v.R.) HOLTUM, Kalikasan 4 (1975) 65. — *Dryopteris dichrotricha* COPEL. Philip. J. Sci. 7 (1912) Bot. 54, non COPEL. 1911. — *Dryopteris dichrotrichoides* v.A.v.R. Handb. Suppl. (1917) Corr. 48, nom. nov. — *D. weberi* COPEL. Philip. J. Sci. 38 (1929) 135, nom. nov. superfl. — *Lastrea dichrotrichoides* (v.A.v.R.) COPEL. Fern Fl. Philip. (1960) 329. — *Thelypteris dichrotrichoides* (v.A.v.R.) REED, Phytologia 17 (1968) 272. — Type: WEBER 1173, Mindanao, Mt Hilong-Hilong (MICH; E, G, K, NSW, P, US).**

*Caudex* short, creeping. *Stipe* 15 cm long, pale, short-hairy; base of stipe to first large pinna 30 cm. *Reduced pinnae* to 5 pairs, upper ones

4 mm long, auricled, lowest very small. *Lamina* 35 cm long; pinnae 18 pairs, basal pinnae a little narrowed towards their bases, strongly auricled on acroscopic base; aerophores swollen. Hairs on both surfaces of *rachis* 1 mm long, pale. *Largest pinnae* 7–12 cm long, 1.5 cm wide at broadly cuneate base from which they are gradually attenuate to apex; edges lobed to 2 mm from costa, lobes oblique, slightly falcate; costules to 3 mm apart; veins 8–9 pairs, basal pair anastomosing near base of pinna, passing to sides of a short sinus-membrane towards apex of pinna; coarse rather sparse hairs 1 mm long on lower surface of costae and costules, shorter hairs on veins and surface between them, glands present on costules and veins, few between veins; hairs on upper surface of costae 1 mm long, similar hairs scattered on costules and veins, whole upper surface covered with fine appressed hairs nearly 0.5 mm long. *Sori* medial, basal ones not divergent; indusia with copious hairs 0.5 mm long; sporangia often with 2–3 glands.

Distr. *Malesia*: Philippines (Mindanao; Panay?).

**86. *Sphaerostephanos nakaikei* HOLTUM, sp. nov.**

*Pinnae redactae 5-jugatae, superiores 10 mm longae, valde auriculatae*; *pinnae normales usque 14 × 2.3 cm, 2/3–3/4 costam versus lobatae*; *venae infimae anastomosantes vel ad basin sinus conniventes*; *costae subtus pilis erectis brevibus vestitae*; *pagina inter venas subtus glandulifera, supra pilis appressis vestita*; *indusia glandulifera, sporangia non glandulifera*. — Type: T. NAKAIKE 358, E. New Guinea, Mt Wilhelm 2500–3500 m (K; TNS).

*Caudex* “massive or ascending” (NAKAIKE). *Stipe* 20 cm long, short-hairy, basal scales broad and thin; base of stipe to first large pinna 45 cm. *Reduced pinnae* 5 pairs, lowest 2 mm long, uppermost 10 mm with basal acroscopic auricle 5 mm long; 1–2 pairs pinnae of intermediate length sometimes present. *Lamina* 60–70 cm long; pinnae 25 pairs; basal large pinnae not narrowed at base, slightly auricled; aerophores slightly elongate. Hairs on lower surface of *rachis* dense, brownish, erect, 0.3–0.5 mm long, on upper surface a little longer. *Largest pinnae* 13–14 cm long, 1.8–2.3 cm wide; base truncate; apex acuminate; edges lobed 2/3–3/4 to costa, lobes falcate, separated by distinct sinuses; costules 5 mm apart; veins 8–10 pairs, basal pair anastomosing with a short excurrent vein to sinus, less commonly both touching sides of short sinus-membrane; lower surface of costae densely covered with erect hairs 0.2 mm long, hairs on costules sparse, glands present on costules and veins and on surface between veins; hairs on upper surface of costae 0.7 mm long, similar hairs scattered on costules and veins, surface between veins rather sparsely covered with

appressed hairs. Sori medial; indusia bearing glands; sporangia with neither setae nor glands.

Distr. *Malesia*: Papua New Guinea (Mt Wilhelm and Mt Giluwe: PARRIS & CROXALL 5900, at 2950 m).

**87. *Sphaerostephanos woitapensis* HOLTUM, sp. nov.**

*S. nakaikeo affinis*, differt: *pinnis minoribus, brevi-stipitatis, inferioribus sensim decrescentibus; lobis pinnarum distaliter dentatis; venis infimis semper anastomosantibus*. — Type: NAKAIKE 576, Papua, Central Distr., Woitape (TNS: K).

*Caudex* thick, short-creeping or ascending. *Stipe* 25 cm long, copiously short-hairy. *Lamina* to 75 cm long; pinnae to more than 20 pairs, distinctly stalked; 5–6 lower pairs gradually decrescent and more widely spaced, lowest 8 mm long; aerophores slightly swollen. Hairs on lower surface of *rachis* suberect, 0.2–0.4 mm long, on upper surface 0.7 mm long. *Largest pinnae* 9.5 × 2.0 cm; base truncate and in some cases slightly dilated both sides; apex short-acuminate; edges lobed c. 3/5 to costa, lobes oblique, slightly falcate, with distinct teeth at ends of some distal veins; costules 4–4.5 mm apart at 60°; veins 6–7 pairs, pale and prominent both sides, basal pair always anastomosing, second pair both to margin; hairs on lower surface of costae near base 0.1 mm, distally 0.3 mm long, on costules and veins sparse and very short, glands present on surface between veins; upper surface of costae hairy as *rachis*, scattered similar hairs on costules and veins, appressed hairs 0.2 mm long between veins. Sori medial; indusia with short hairs and many glands; sporangia lacking glands and setae.

Distr. *Malesia*: Eastern New Guinea at 2500–2800 m.

Note. Other collections have smaller pinnae than the type, on smallest fronds 5.0 × 1.2 cm, rather rigid; these do not show teeth at ends of distal veins.

**88. *Sphaerostephanos ekutiensis* HOLTUM, sp. nov.**

*Pinnae redactae* 8-jugatae, usque 10 mm longae; *pinnae normales* usque 7.0 × 1.8 cm, c. 3/5 *costam versus lobatae*; *venae* 7-jugatae, *inimae solum anastomosantes*; *costae subtus pilis paucis praedita*, *pagina inferior pinnarum cetera glabra*, *glandulifera*, *glandulis inter venas paucis*; *sori inframediales*; *indusia tenuia*, *glandulis multis ornata*; *sporangia nec setis nec glandulis praedita*. — Type: B. S. PARRIS & J. P. CROXALL 6022, N.E. New Guinea, Morobe Distr., Ekuti Range (CGE: K).

*Caudex* not known; *stipe* 7 cm long, glabrous on abaxial surface, scales at base 7 × 1.5 mm; base of *stipe* to first normal pinna 30 cm; *reduced pinnae* 8 pairs, uppermost 10 × 4 mm with an auricle 8 mm

long, lowest 5 mm long, deflexed, narrowly triangular with acroscopic auricle 3 mm long; two pairs of pinnae of intermediate length present between reduced and normal pinnae. *Lamina* excluding reduced pinnae 37 cm long; pinnae 18 pairs, all opposite, texture firm; basal pinnae not narrowed at their bases. Both surfaces of *rachis* bearing thick curved pale brown hairs 1 mm long. *Largest pinnae* 7.0 × 1.8 cm, sessile; aerophores slightly swollen; base subtruncate, not auricled; apex abruptly short-caudate; edges lobed 3/5 towards costa, lobes slightly falcate with rounded tips; costules 4 mm apart, at more than 60° to costa; veins to 7 pairs, basal pair anastomosing, next pair to margin; lower surface of costae bearing rather sparse thick pale hairs 0.3 mm long and glands, rather large glands and no hairs on costules and veins, rather sparse glands between veins; upper surface of costae covered with pale hairs less than 1 mm long, shorter hairs scattered on costules and veins, no other hairs. Sori inframedial; indusia thin, with many glands; sporangia bearing neither setae nor glands.

Distr. *Malesia*: Papua New Guinea; only known from the type.

Ecol. In *Nothofagus* forest at 2250 m.

**89. *Sphaerostephanos omatianus* HOLTUM, sp. nov.**

*Stipes* 2.5 cm longus; *lamina* 7–8 cm longa, *pars apicalis profunde lobata* 5.5 cm longa, *pinnae liberae* 3–4-jugatae, *crenatae*, *inimae leviter redactae*; *venae liberae*; *costae costulaeque subtus pilis longis glandulisque praeditae*; *sori exindusiati*, *sporangia nuda*. — Type: WOMERSLEY & SIMMONDS 5076A, Papua, Gulf Div., Omati (BRI).

*Caudex* apparently short-creeping. *Stipe* 2.5 cm long, covered with pale spreading hairs 1 mm long. *Lamina* 7–8 cm long, apical 5.5 cm deeply lobed, grading to pinnae; free pinnae 3–4 pairs, lowest only reduced, 6–7 mm long, deflexed and a little narrowed on basiscopic side. *Largest pinnae* 1.1 × 0.45 cm, almost sessile; base broadly cuneate; apex obtusely pointed; edges crenate near base, entire distally; costules near base of pinnae hardly 2 mm apart, twice forked, distal ones forked or simple, all veins free; lower surface of *rachis*, costae and costules bearing hairs 1 mm long and some shorter ones, slender erect hairs on surface between veins, glands present on costae and costules; slender hairs 1 mm long on upper surface of costae and costules, appressed hairs on surface generally. Sori in an uneven row on each side of costa, on acroscopic branches of forked costules; no indusia; neither glands nor setae on sporangia; spores minutely papillose.

Distr. *Malesia*: Papua, known only from type collection.

Ecol. At an altitude of 30 m, in shallow soil over pinnacle limestone, in dense rain-forest.

**90. *Sphaerostephanos alticola* HOLTUM, sp. nov.**

*Caudex brevis, crassus; stipes 12 cm longus; lamina 45–55 cm longa; pinnae 40-jugatae, 12–14-jugatae inferiores sensim decrescentes, maximae 3.3 cm longae, 7–8 mm latae, leviter lobatae, rigidae, lobis cucullatis; costae costulaeque subtus patenti-pilosae paulo glandulosae; indusia parva, glandulis pilisque praedita; sporangia setifera.* — Type: HOOGLAND 9762, N.E. New Guinea, Huon Peninsula, Salawaket Range (LAE; L).

*Caudex* "thick,  $\pm$  horizontal". *Stipe* 12 cm long, base covered with glossy scales  $10 \times 1.3$ –3 mm. *Lamina* 45–55 cm long; *pinnae* to 40 pairs, rigidly coriaceous, lower 12–14 pairs gradually smaller and more widely spaced, lowest 5 mm long, 6 mm wide at truncate base, 3-lobed, upper ones triangular, crenate; aerophores not elongate. *Rachis* covered with dense pale spreading hairs 0.7 mm long. *Largest pinnae* 3.3 cm long, 7–8 mm wide above base, base truncate and a little dilated; apex shortly obtuse; edges lobed to a depth of 1 mm or a little more deeply; lobes rounded, their edges much deflexed so that the lower surface is concave; costules little more than 2 mm apart; veins 3–5 pairs, pale, prominent both sides, 1 pair anastomosing, next pair to short sinus-membrane; lower surface of costae covered with erect thick pale hairs to 1 mm long, similar hairs sparse on costules; sparse glands present on costules and veins; upper surface of costae densely hairy, similar hairs more sparse on costules and veins, some erect hairs between veins. *Sori* medial; indusia small, bearing glands and short hairs; sporangia setiferous; spores with many small wings.

*Distr. Malesia:* Papua New Guinea (Salawaket Range); 2 collections.

*Ecol.* "In low open forest on landslide, limestone". 2500–3200 m.

**91. *Sphaerostephanos rigidus* (RIDL.) HOLTUM, comb. nov.** — *Goniopteris rigida* RIDL. Trans. Linn. Soc. Bot. 9 (1916) 258. — *Phegopteris wolastonii* v.A.v.R. Handb. Suppl. (1917) 515, *nom. nov.*, not *P. rigida* (HOOK. & GREV.) METT. — *Thelypteris rigida* (RIDL.) REED, Phytologia 17 (1968) 309. — Type: C. B. KLOSS s.n. 18 Feb. 1913, W. New Guinea, Mt Carstensz, Camp VIC, 1680 m (BM; K).

*Caudex* lacking from type and *stipe* incomplete. *Lamina* to 40 cm long; *pinnae* to 30 pairs; basal 3–4 pairs *pinnae* gradually decrescent, lowest  $2.2 \times 0.6$  cm, below them 3 pairs reduced *pinnae* 3–4 mm long; aerophores c. 0.5 mm long. *Rachis* bearing throughout stiff spreading brown hairs to 1.2 mm long. *Largest pinnae*  $6.0 \times 1.3$  cm; base truncate and slightly dilated both sides; apex narrowed to a short obtuse or rounded tip; edges lobed 1/4–1/3 to costa, lobes rounded with edges strongly reflexed (lower surface thus concave); costules 2.5 mm apart, pale and prominent on lower sur-

face, grooved above; veins 4–5 pairs, prominent beneath, one pair anastomosing, next acroscopic vein to sinus-membrane; stiff brown hairs to 0.7 mm long on lower surface of costae, more sparse on costules, veins and edge, glands present on costae and costules; upper surface of *pinnae* glabrous apart from sparse short hairs on costae. *Sori* medial; indusia very small with a few stiff hairs (sometimes absent?); sporangia with neither glands nor hairs on body, yellow glands sometimes on their stalks.

*Distr. Malesia:* Western New Guinea; 2 collections at 1700 m; on limestone?

*Note.* The second collection, EYMA 4986 from Wissel Lake region, is small, with lamina of fronds 15 cm long, *pinnae* to 2 cm long, 3–4 pairs lower ones gradually reduced, lowest 8 mm long; the caudex is short-creeping. It seems probable that the type was found on limestone.

**92. *Sphaerostephanos arfakianus* (BAK.) HOLTUM, comb. nov.** — *Polypodium arfakianum* BAK. in Beccari, Malesia 3 (1880) 45. — *Dryopteris arfakianus* (BAK.) C. CHR. Ind. Fil. (1905) 253; Dansk Bot. Ark. 9, n. 3 (1937) 50. — *Phegopteris arfakiana* (BAK.) v.A.v.R. Handb. (1908) 502. — *Cyclosorus arfakianus* (BAK.) COPEL. Gen. Fil. (1947) 142; Philip. J. Sci. 78 (1951) 451. — *Thelypteris arfakiana* (BAK.) REED, Phytologia 17 (1968) 260. — Type: BECCARI s.n. 1872, W. New Guinea, Mt Arfak at Putat (FI; K).

*Dryopteris sepikensis* BRAUSE, Bot. Jahrb. 56 (1920) 101; COPEL. Philip. J. Sci. 78 (1951) 443. — Type: LEDERMANN 12053, N.E. New Guinea, Schraderberg (B).

*Dryopteris arborea* v.A.v.R. Bull. Jard. Bot. Btzig II, 28 (1918) 24, *non* BRAUSE 1914. — *Dryopteris rosenburghii* C. CHR. Ind. Fil. Suppl. III (1934) 96. — Type: RUTTEN 161, Ceram (BO).

*Caudex* slender, erect, to at least 100 cm tall. *Stipe* 10–20 cm long, dark, short-hairy. *Lamina* to 80 cm long,  $\pm$  dimorphous, thin; *pinnae* to 40 pairs, lowest 6–10 pairs gradually smaller, lower ones broadly triangular with slightly asymmetric base, entire; aerophores not elongate. Hairs on both sides of *rachis* less than 0.5 mm long, brownish,  $\pm$  appressed. *Largest sterile pinnae*  $12-17 \times 2.2$ –4 cm, fertile commonly to  $10 \times 1.5$  cm, sometimes larger; base broadly cuneate to truncate, sometimes a little dilated both sides; apex acuminate; edges shallowly crenate or sinuous; costules to 4.5 mm apart on large *pinnae*; veins 5–7 pairs, slender, concolorous, slightly prominent both sides, almost all anastomosing to form zigzag excurrent veins between costules; hairs on lower surface of costae 0.1–0.2 mm long, slender, appressed, similar hairs on costules and veins, also sometimes a few glands; hairs on upper surface of costae 0.3–0.4 mm long, on costules shorter and sparse, usually a few slender appressed hairs on surface between veins at least near mar-



gin. *Sori* inframedial; indusia small, thin, usually with a few hairs; sporangia bearing glands.

Distr. *Malesia*: Moluccas (Ceram;? Amboina, BROOKS 18102) and widely in New Guinea.

Ecol. In forest at altitudes to 2000 m.

Note. The type of *D. sepikensis* and some others from an altitude of about 2000 m are smaller than BECCARI's type and other lowland specimens, with fewer reduced pinnae and distinctly lobed sterile ones, but agree in details of pubescence and sori.

**93. *Sphaerostephanos archboldii* (C. CHR.) HOLTUM, comb. nov.**—*Dryopteris archboldii* C. CHR. Brittonia 2 (1937) 297. — *Thelypteris archboldii* (C. CHR.) REED, Phytologia 17 (1968) 260. — Type: BRASS 4873, Papua, Mt Tafa, valley forest, 2400 m (BM; BRI).

*Dryopteris protecta* COPEL. Univ. Cal. Publ. Bot. 18 (1942) 221. — *Cyclosorus protectus* (COPEL.) COPEL. Gen. Fil. (1947) 143; Philip. J. Sci. 78 (1951) 453, pl. 33. — *Thelypteris protecta* (COPEL.) REED, Phytologia 17 (1968) 306. — Type: BRASS 10933, New Guinea, 9 km N.E. of Lake Habbema, 2800 m (MICH; BM, L). — Fig. 13d-e.

*Caudex* slender, erect, to 100 cm or more tall. *Stipe* 5–15 cm long, minutely hairy, when young covered with rather firm brown scales  $7 \times 1$  mm. *Lamina* to 65 cm long, texture very firm; lower 8–15 pairs pinnae gradually smaller, lowest 3–6 pairs of these more widely spaced with asymmetric base, lowest c. 1 mm long; aerophores not elongate. Hairs on lower surface of *rachis* erect, to 0.5 mm long, on upper surface a little longer, also spreading. *Largest pinnae* of type to  $6 \times 1.0$  cm (type of *D. protecta*  $9 \times 1.5$  cm); base truncate; apex evenly attenuate; edges lobed about 1/3 to costa; costules to 3 mm apart; veins 4–6 pairs, prominent on lower surface,  $1\frac{1}{2}$  pairs anastomosing, next acroscopic vein or pair to short sinus-membrane; hairs on lower surface of costae 0.1–0.3 mm long, antrorse distally, sparse glands and hairs on costules and veins (glands best seen on sterile fronds); hairs on upper surface of costae short, sparse on costules, veins and between veins. *Sori* near costules; indusia bearing hairs and glands; sporangia sometimes with a seta.

Distr. *Malesia*: Eastern New Guinea at 1800–2800 m, many collections.

**94. *Sphaerostephanos tibangensis* (C. CHR.) HOLTUM, comb. nov.**—*Dryopteris tibangensis* C. CHR. Dansk Bot. Ark. 9, n. 3 (1937) 66. — *Pronephrium tibangense* (C. CHR.) HOLTUM, Blumea 20 (1972) 118. — Type: MÖBERG s.n. Oct.–Dec. 1925, E. Kalimantan, Mt Tibang, 1400–1700 m (BM; S-PA).

*Caudex* short, suberect; *stipe* to 20 cm long, short-hairy. *Lamina* to 20 cm long; no reduced basal pinnae; normal pinnae 8–10 pairs, lower

ones with stalks to 2 mm long; basal pinnae slightly shorter than next pair, with 3 pairs of basal basicopic lobes slightly reduced. *Largest pinnae*  $3.5 \times 1.4$  cm; base truncate and slightly auricled on the acroscopic side, narrowed rather evenly from base to acute apex; edges lobed 2/5 towards costa or rather more deeply; lobes sub-falcate, acute; costules 3 mm apart, at more than  $60^\circ$  to costa; veins 6 pairs, basal pair anastomosing, second pair to sides of sinus-membrane, rest to margin; lower surface of costae and costules bearing pale spreading hairs 0.2–0.6 mm long, short erect hairs present between veins, many glands on costules and veins; upper surface of costae copiously short-hairy, rest of surface bearing short suberect hairs. *Sori* supramedial; indusia small, densely short-hairy; sporangia not setiferous.

Distr. *Malesia*: East Borneo (Mt Tibang), 1400–1700 m.

Note. This is certainly very near *S. norrisii*. The type consists of one fertile and one sterile frond, the latter not quite fully expanded, with immature sori. The fertile frond is smaller than any specimen undoubtedly referable to *S. norrisii*, and the pinnae are of a different shape; mature sori might show further differences.

**95. *Sphaerostephanos norrisii* (ROSENST.) HOLTUM, comb. nov.**—*Dryopteris norrisii* ROSENST. Med. Rijksherb. n. 31 (1917) 8. — Type: W. NORRIS, Malaya (L; K).

*Nephrodium pennigerum* var. *malayense* BEDD. Handb. Suppl. (1892) 74, excl. Parish, Tenasserim. — *Dryopteris indica* var. *malayensis* (BEDD.) v.A.v.R. Handb. (1908) 224. — Lectotype (selected here): KUNSTLER 2360, Perak (K).

*Dryopteris subfalcinella* v.A.v.R. Bull. Jard. Bot. Btzg III, 2 (1920) 151. — *Thelypteris subfalcinella* (v.A.v.R.) REED, Phytologia 17 (1968) 317. — Lectotype (selected here): LÖRZING 5338, Sumatra, Bandar-baroe (BO; L).

*Dryopteris elmerorum* COPEL. Philip. J. Sci. 40 (1929) 295, pl. 2. — *Cyclosorus elmerorum* (COPEL.) COPEL. Gen. Fil. (1947) 142; Fern Fl. Philip. (1960) 351. — *Thelypteris elmerorum* (COPEL.) REED, Phytologia 17 (1968) 274. — *S. elmerorum* (COPEL.) HOLTUM, Kalikasan 4 (1975) 53. — Type: COPELAND s.n. Nov. 1911, Mindanao, San Ramon (MICH).

*Nephrodium indicum* sensu RIDL. J. Mal. Br. R. As. Soc. 4 (1926) 73.

*Dryopteris toppingii* sensu C. CHR. Gard. Bull. Str. Settl. 4 (1929) 391. — *Cyclosorus toppingii* sensu HOLTUM, Rev. Fl. Mal. 2 (1955) 280, f. 161.

*Cyclosorus ellipticus* sensu COPEL. Fern Fl. Philip. (1960) 351. — Fig. 12f-h.

*Caudex* short-creeping. *Stipe* 30–90 cm long, dull reddish, minutely hairy; reduced pinnae 0–3 pairs, present only on largest fronds, irregularly spaced and very small. *Lamina* to 100 cm long

(type), on type of *D. elmerorum* 30 cm long; pinnae 10–18 pairs, several pairs distinctly stalked; basal pinnae often somewhat reduced if small reduced pinnae absent, with stalks 1–3 mm long, narrowed towards their bases, not auricled; aerophores not elongate. Hairs on lower surface of *rachis* dense, short, stiff, erect; on upper surface copious, appressed, less than 0.5 mm long. *Largest pinnae* of type  $24 \times 3.4$  cm, of type of *D. elmerorum*  $6.5 \times 1.8$  cm; base subtruncate on large fronds, subcordate on small ones; apex rather abruptly short-acuminate; edges lobed c. 2/5 towards costa (less deeply on small fronds), lobes falcate with broadly pointed or rounded forward-pointing tips; costules 5–6 mm apart ( $3.5$ – $4$  mm in type of *D. elmerorum*); veins to 12 pairs,  $1$ – $1\frac{1}{2}$  pairs anastomosing,  $2$ – $2\frac{1}{2}$  pairs passing to sides of sinus-membrane; hairs on lower surface of costae and costules dense, short, erect, some short hairs also between veins, glands present on costules at least near apex of pinna-lobes; hairs on upper surface of costae and costules short, some short appressed or suberect hairs on surface between veins. *Sori* supramedial, somewhat elongate, especially the lower ones; indusia large, densely short-hairy, sometimes with a few glands; sporangia sometimes with a gland or a short seta.

Distr. *Malesia*: Malaya, Sumatra, Borneo, Philippines (Mindanao).

Ecol. In forest at 1000–1500 m; apparently not common anywhere.

Note. Though the type of *D. elmerorum* is small, other specimens from Mindanao have pinnae to  $15 \times 3$  cm. No small fertile fronds have been found on plants in Sumatra and Malaya. Some specimens have very few glands on the lower surface of costules. Specimens from Sumatra and Malaya have appressed hairs between the veins on the upper surface, specimens from Borneo and Mindanao have shorter suberect hairs.

**96. *Sphaerostephanos semimetralis* HOLTUM sp. nov.**

*S. arfakiano affinis*, differt: *frondibus minoribus*; *pinnis redactis* 2–3-jugatis, minutis; *pinnis fertilibus usque*  $5 \times 1.2$  cm; *costis costulisque subtus pilis sparsis suberectis instructis*. — Type: PULLE 518, W. New Guinea, Perameles Mts, 1100 m, on limestone (L).

*Caudex* erect, slender, 50 cm tall. *Stipe* 15 cm long, basal scales c.  $8 \times 1$  mm; base of stipe to first large pinna 25–30 cm. *Reduced pinnae* 2–3 pairs, all very small, with above them an apparently much larger intermediate pair (incomplete). *Lamina* 35 cm long; pinnae 10–12 pairs, very firm, dimorphous; basal pinnae not narrowed at base; aerophores less than 0.5 mm long. Hairs on lower surface of *rachis* thick, brown, 0.5 mm long, on upper surface similar, to 1 mm long. *Largest sterile pinnae*  $9 \times 2.2$  cm; base truncate with a winged stalk 1 mm long; apex abruptly short-acuminate;

edges crenate to a depth of 1–2 mm; costules  $3.5$ – $4$  mm apart, at  $60^\circ$ ; veins 6–8 pairs, very oblique except basal ones, prominent both sides, 2 pairs anastomosing to form a zig-zag excurrent vein, 1 pair to short sinus-membrane; lower surface of costae bearing sparse erect hairs 0.1 mm long, similar hairs very sparse on costules and veins with a few glands, sparse erect hairs between veins; hairs on upper surface of costae pale, 0.5 mm long, rest of surface glabrous. *Fertile pinnae* to  $5 \times 1.2$  cm; veins 5 pairs; pubescence as sterile; sori near costules; indusia small with a few short hairs and glands; sporangia sometimes with a gland.

Distr. *Malesia*: New Guinea. A specimen from N.E. New Guinea, Western Highlands, at KOMPIAI in the Jimmi valley at 1900 m (MANNER & STREET 454), probably not from limestone, is similar to the type.

Note. This differs from the mountain form of *S. arfakianus* in the very small reduced pinnae, and in pubescence of lower surface; but better specimens are needed to characterize it clearly.

**97. *Sphaerostephanos semicordatus* HOLTUM, sp. nov.**

*Pinnae redactae* 8-jugatae, omnes minutae; *lamina* 35 cm longa; pinnae 10–12-jugatae, omnes oppositae, subintegrae; *costulae subtus glabrae, glanduliferae*; *sori exindusiati*; *sporangia setifera*; *sporangia alatae*. — Type: PULLEN 1476, N.E. New Guinea, Sepik Distr., Prince Alexander Range, 900 m (CANB).

*Caudex* short, creeping. *Stipe* 8 cm long, reddish, glabrescent, basal scales  $3 \times 1.5$  mm; base of stipe to first large pinna 60 cm. *Reduced pinnae* 8 pairs or more, 5–6 cm apart, all very small. *Lamina* 35 cm long; pinnae 10–12 pairs, all opposite, basal pinnae not narrowed at their bases; aerophores slender, to 1 mm long. Hairs on *rachis* both sides 0.5 mm long, on upper surface brown. *Largest sterile pinnae*  $14 \times 2.5$  cm, fertile to  $10 \times 2.0$  cm; basiscopic base cordate and overlapping *rachis*, acroscopic truncate or slightly cordate; apex acuminate; edges irregularly sinuous to slightly crenate; costules 4.5 mm (sterile) 3.5 mm (fertile) apart, at more than  $60^\circ$ ; veins 6–7 pairs,  $3\frac{1}{2}$  pairs anastomosing, one vein to short sinus-membrane; lower surface of costae minutely hairy, rest of lower surface glabrous, glands present on costules; on upper surface base of costae covered with brown hairs as *rachis*, above base spare short hairs, rest of upper surface glabrous. *Sori* on distal veins medial, on lower ones supramedial, those on veins from adjacent costules often coalescent; no indusia; sporangia with 4–6 setae; spores with a  $\pm$  continuous translucent wing and a few irregular other wings.

Distr. *Malesia*: Papua New Guinea (Sepik).

**98. *Sphaerostephanos pterosporus* (v.A.v.R.)**

HOLTUM, *comb. nov.* — *Dryopteris pterospora* v.A.v.R. Bull. Jard. Bot. Btzig III, 2 (1920) 148. — *Thelypteris pterospora* (v.A.v.R.) REED, Phytologia 17 (1968) 307. — Type: BROOKS 447, Sumatra, Benkoelen, Tambang Sawah (BO; BM).

*Dryopteris bungoensis* C. CHR. Dansk Bot. Ark. 9, n. 3 (1937) 59. — Type: BROOKS 10, April 1909, Sarawak, Bungo Range (BM).

#### KEY TO THE VARIETIES

1. Pinnae lobed at least 1/3 towards costa.
2. Pinnae lobed less than 1/2 towards costa; basal pair of veins often anastomosing
  - a. *var. pterosporus*
2. Pinnae lobed 3/5–2/3 towards costa; basal veins rarely anastomosing . . . . . b. *var. altilobus*
1. Pinnae crenate . . . . . c. *var. crenatus*

#### a. *var. pterosporus*

*Caudex* short, erect. *Stipe* 3–10 cm long, basal scales 8 × 1 mm; base of stipe to first normal pinna 20–30 cm (sterile fronds) 30–45 cm (fertile fronds). *Reduced pinnae* 6–8 pairs, all less than 2 mm long. *Lamina* c. 40 cm long; pinnae to 18 pairs, basal pinnae narrowed to a width of 6–8 mm or less at base; aerophores less than 1 mm long. Hairs on lower surface of *rachis* of sterile fronds thick, brown, curved, to 1 mm long, on fertile paler and shorter; hairs on upper surfaces as on lower surface of sterile. *Largest sterile pinnae* to 12 × 2 cm; base truncate; apex rather abruptly caudate-acuminate; edges lobed less than 1/2 towards costa, lobes falcate with forward-pointing tips; costules 4.5–5 mm apart, at 60° to costa; veins 5–7 pairs, all very oblique, basal pair uniting to form an excurrent vein to sinus or touching just below sinus, next acroscopic vein to side of sinus-membrane or to margin; hairs on *lower surface* of costae 0.3 mm long, pale, closely appressed, on costules and veins similar, sometimes also a few glands, on surface between veins some fine appressed hairs may be present but not glands; hairs on *upper surface* of costae 0.5 mm long with some to 1 mm, on costules and veins short and sparse, sometimes a few appressed hairs between veins. *Fertile pinnae* to 7 × 1.4 cm, lobed a little more deeply than sterile; costules 3.5 mm apart; basal veins more often connivent at the sinus without joining. *Sori* medial; indusia firm with short hairs; sporangia bearing glands; spores with many small separate wings.

Distr. *Malesia*: Southern Malaya (several localities), S. Sumatra, W. Sarawak, in forest at 9–700 m.

#### b. *var. altilobus* HOLTUM, *var. nov.*

A *typo speciei differt*: *pinnis maximis sterilibus usque* 14 × 2.6 cm, *fertilibus* 10 × 1.8 cm, 3/5–2/3 *costam versus lobatis*; *venis infimis plerisque ad sinum conniventibus*, *raro anastomosantibus*. —

Type: MOLESWORTH ALLEN 2736, Perak, Maxwell's Hill, 730 m, in forest, "deep green fronds, brown rachis, quite distinct" (K). Also from Taiping Hills: KUNSTLER 6345, at 750–900 m, "pinnae dark green".

Distr. *Malesia*: Malaya.

#### c. *var. crenatus* HOLTUM, *var. nov.*

A *typo speciei differt*: *pinnis crenatis*; *venis* 1½-jugatis *anastomosantibus*, *vena sequente acroscopica ad membranam sinus terminata*; *pinnis fertilibus usque* 10 × 1.5 cm. — Type: JERMY 13870, Sarawak, G. Mulu National Park, by Tapin River (BM). Also M. HOTTA 13809, Brunei, along Sungei Lacquan, 50–300 m (L).

Distr. *Malesia*: Borneo (Sarawak; Brunei).

99. *Sphaerostephanos sagittifolius* (BL.) HOLTUM, *comb. nov.* — *Aspidium sagittifolium* BL. Enum. Pl. Jav. (1828) 153; MIQUEL, Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 150. — *Nephrodium sagittifolium* (BL.) MOORE, Ind. Fil. (1858) 103; RACIB. Fl. Btzig 1 (1898) 191. — *Dryopteris sagittifolia* (BL.) O. Ktze, Rev. Gen. Pl. 2 (1891) 813; v.A.v.R. Handb. (1908) 222; BACKER & POSTH. Varenfl. Java (1939) 52. — *Thelypteris sagittifolia* (BL.) REED, Phytologia 17 (1968) 311. — Type: BLUME, Java (L. n. 908, 336–24).

*Caudex* short, massive, decumbent or suberect; young fronds covered with slime. *Stipe* 15 cm long; scales (*fide* RACIBORSKI) 4 × 3 mm; base of stipe to first large pinna 50–80 cm. *Reduced pinnae* more than 30 pairs, 1.5–2 cm apart, deflexed, upper ones 2.5–3.0 cm long with basal auricle to 1.5 cm, apex acuminate, edges crenate; lowest 1 cm long. *Lamina* 100 cm or more long; several pairs lower pinnae with elongate basal acroscopic auricle in which veins are forked; aerophores thick but hardly 1 mm long. *Rachis* covered with thick spreading hairs more than 1 mm long, both sides. *Largest pinnae* to 20 × 2.3 cm; base truncate, basal acroscopic lobe somewhat elongate; apex caudate-acuminate; edges lobed 2/5 to costa, lobes with falcate tips; costules 5–5.5 mm apart at more than 60°; veins to 10 pairs, pale and prominent on lower surface, 1½–2 pairs anastomosing, 2–2½ pairs to sides of sinus-membrane; hairs on *lower surface* of costae stiff, spreading, of varying length to 1 mm, on costules similar but sparse, a few glands on costules and veins; hairs on *upper surface* of costae 1 mm long, scattered similar hairs on costules and veins, no others. *Sori* medial, basal ones divergent; indusia small with stiff hairs 0.3 mm long; sporangia bearing glands or setae; spores with many small wings.

Distr. *Malesia*: Sumatra, Java, and Lesser Sunda Is. (Lombok).

Ecol. In forest at 1000–1500 m.

Note. v.A.v.R. (Handb. Suppl. 182) reported specimens from New Guinea; I did not find these in Herb. Bog.

**100. *Sphaerostephanos foliolosus* HOLTUM, sp. nov.** — *Aspidium hirsutum* and *A. cucullatum* sensu CHRIST, Ann Jard. Bot. Btzg 15 (1898) 134, quoad Sarasin 745 tantum.

*S. polyoti affinis, differt: pinnis c. 2/5 costam versus lobatis; venis inferioribus 2½–3-jugatis vel anastomosantibus vel ad membranam sinus conniventibus; aerophoris usque 1 mm longis; pinnis redactis superioribus minoribus.* — Type: P. & F. SARASIN 745, N. Celebes, G. Matinang 350 m (BAS).

*Stipe* to 15 cm long; scales broad, thin; base of stipe to first large pinna 60 cm. *Reduced pinnae* c. 30 pairs, 1–1.5 cm apart, upper ones to 12 × 6 mm, lowest 4–8 mm long, shape as in *S. polyotis*, covered with mucilage when young. *Lamina* 65–70 cm long; pinnae 30 pairs, lower ones not narrowed at base; aerophores slender, to 1 mm long. Lower surface of *rachis* densely short-hairy (sometimes with longer hairs?); brown hairs to 1 mm long on upper surface. *Largest pinnae* 15 × 1.8 cm, base subtruncate, symmetric (more cuneate and less symmetric on upper pinnae); apex gradually attenuate, not caudate; edges lobed c. 2/5 to costa, lobes falcate with obtusely pointed tips; costules 3 mm apart, at 60° or more; veins 8–10 pairs, 1½ pairs anastomosing, 1½–2 pairs passing to sides of sinus-membrane; hairs on lower surface of costae short, dense, mixed with long ones on sterile fronds, sparse hairs with glands on costules and veins, short erect hairs between veins; upper surface of costae bearing pale hairs 1 mm long, rest of surface ± closely covered with slender appressed hairs. *Sori* medial; indusia small, pilose; sporangia usually with 1–2 glands, sometimes a seta.

*Distr. Malesia:* N. Celebes, Moluccas (Talaud Islands): LAM 2786, 2788, on river bank at 80–350 m).

*Note.* LAM's sterile specimens differ from the type (which is fertile) in the presence of hairs 1 mm long on lower surface of rachis and costae.

**101. *Sphaerostephanos alpinus* HOLTUM, sp. nov.**

*Pinnae redactae* 6–7-jugatae, superiores 12 mm longae; lamina 45 cm longa; pinnae maximae 9.5 × 1.8 cm, ¾ costam versus lobatae; costae, costulae venaque subtus glandulosae, pagina inter venas pilosa; pagina superior pilis appressis vestita; indusia glandulis et pilis brevibus praedita; sporangia nec glandulis nec setis praedita. — Type: A. C. JERMY 5248, N.E. New Guinea, Western Highlands, Keglsugl (BM).

*Caudex* short, creeping. *Stipe* 15–20 cm long, minutely hairy, basal scales broad, thin; base of stipe to first large pinna 45–50 cm. *Reduced pinnae* 6–7 pairs, 3–4 cm apart, lowest 5–7 mm long, upmost 12 mm long, somewhat deflexed, narrowly triangular, with auricle 6–8 mm long on acroscopic base. *Lamina* 45 cm long; pinnae to 24

pairs; basal pinnae not or little narrowed at their bases; aerophores thick, hardly 1 mm long. Hairs on lower surface of *rachis* dense, short, spreading, on upper surface 1 mm long. *Largest pinnae* 9.5 cm long, 1.8 cm wide above slightly dilated base; apex acuminate with cauda 1.5 cm; edges lobed almost or quite ¾ to costa, lobes slightly falcate; costules 3.5–4 mm apart, their bases almost at right angles to costa; veins 9 pairs, at a wide angle, pale and prominent both sides, basal pair anastomosing, next pair usually both to margin; lower surface of costae densely covered with short spreading hairs, hairs less dense, with glands, on costules, surface between veins with short erect hairs; hairs 1 mm long on upper surface of costae, similar hairs scattered on costules and veins, whole upper surface covered with appressed hairs. *Sori* medial; indusia bearing glands and short hairs; sporangia with neither glands nor setae; spores with many small wings.

*Distr. Malesia:* Papua New Guinea.

*Ecol.* Type locality at 2500–2750 m, and Mt Wilhelm at 3300–3500 m (NAKAIKE 274).

**102. *Sphaerostephanos polisianus* HOLTUM, Kalikasan 4 (1975) 65.** — Type: M. G. PRICE 431, Luzon, Mountain Prov. Mt Polis (CAHUP; K).

*Caudex* creeping, 5–6 mm diameter, bearing a close series of fronds. *Stipe* 4–5 cm long, minutely hairy, basal scales short and firm; base of stipe to first large pinna 25–30 cm. *Reduced pinnae* 3–4 cm apart, all very small. *Lamina* to 28 cm long; pinnae 14 pairs, lowest narrowed at their bases; aerophores 1 mm long. Lower surface of *rachis* covered with very short erect reddish hairs, upper surface with thick curved dark red hairs 0.5 mm long. *Largest pinnae* 6.5 × 1.3 cm; base subtruncate; apex short-acuminate; edges lobed ½ way to costa, lobes oblique with forward-pointing obtuse tips; costules 3–3.5 mm apart at 60°; veins 6–7 pairs, slender and prominent on lower surface, basal pair anastomosing, next acroscopic vein to side of short sinus-membrane; lower surface of costae covered with hairs 0.1 mm long or a little more, antrorse at least distally, few similar hairs on costules, glands on costules and veins; hairs on upper surface of costae 0.3 mm long, rest of upper surface glabrous. *Sori* medial; indusia small, glabrous; sporangia sometimes with a gland.

*Distr. Malesia:* Philippines (Luzon); only known from the type.

*Note.* This should perhaps be regarded as a form of *S. lobatus*.

**103 *Sphaerostephanos hoalensis* HOLTUM, sp. nov.** — *Dryopteris ceramica* ROSENST. MS, non v.A.v.R.

*Pinnae redactae* c. 13-jugatae, superiores 15 × 8 mm, infimae 10 mm longae; aerophora elongata; pinnae maximae 11 × 2 cm, dimidio costam versus lobatae; costae subtus pilis erectis usque

1 mm longis vestitae, costulae pilis brevioribus glandulisque praeditae; pagina superior pilis appressis vestita; indusia pilifera; sporangia glandulifera. — Type: STRESEMANN 110, Ceram, Central Mts. G. Hoale, 1000 m (L).

*Stipe* lacking. *Reduced pinnae* 2.5 cm apart, c. 13 pairs, one near the base 10 mm long, uppermost 15 × 8 mm, deflexed, slightly auricled on acroscopic base, edges crenate, apex obtuse to rounded. *Lamina* c. 60 cm long; lowest pinnae not narrowed at base; aerophores elongate. Lower surface of *rachis* covered with erect hairs 0.2–0.3 mm long and some longer ones, hairs on upper surface 1 mm long. *Largest pinnae* 11 × 2 cm; base truncate; apex abruptly short-acuminate; edges lobed c.  $\frac{1}{2}$  way to costa, lobes oblique, slightly falcate; costules 3 mm apart, at more than 60°; veins 9 pairs,  $1\frac{1}{2}$  pairs anastomosing, next acroscopic vein to sinus-membrane; lower surface of costae hairy as rachis, costules and veins less densely covered with shorter hairs and some glands, surface between veins bearing short erect hairs; hairs on upper surface of costae 1 mm long, shorter ones on costules, appressed hairs all over surface. *Sori* small, medial to supramedial, lower ones a little divergent; indusia with many rather long hairs; sporangia bearing 1 or 2 glands.

Distr. *Malesia*: Moluccas (Central Ceram, 2 collections, second one n. 57).

Ecol. In the mountains, 1000 m.

**104. *Sphaerostephanos larutensis* (BEDD.) C. CHR.** Ind. Fil. Suppl. III (1934) 172. — *Nephrodium larutense* BEDD. Handb. Suppl. (1892) 73. — *Mesochlaena larutensis* (BEDD.) v.A.v.R. Handb. (1908) 232, incl. var. *borneensis*. — *Cyclosorus larutensis* (BEDD.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 245; HOLTUM, Rev. Fl. Mal. (1955) 284, f. 165. — *Thelypteris larutensis* (BEDD.) REED, Phytologia 17 (1968) 286. — Lectotype (here selected): KUNSTLER 2398, Perak, Larut (K).

*Mesochlaena sumatrensis* v.A.v.R. Bull. Jard. Bot. Botz III, 2 (1920) 160. — *S. sumatrensis* (v.A.v.R.) C. CHR. Ind. Fil. Suppl. III (1934) 172. — Type: BROOKS 391, Sumatra, Benkoelen, Lebong Tandai (BO; BM). — Fig. 12d–e.

*Caudex* short, creeping. *Stipe* 20–30 cm long, above base covered with spreading hairs to 1 mm long; base of stipe to first large pinna 40–70 cm. *Reduced pinnae* 6–12 pairs, lower ones less than 1 cm long, upper ones c. 1.5 × 1.2 cm, spreading, triangular, edges crenate, apex acute; an intermediate pair sometimes present. *Lamina* 50–70 cm long; apex pinna-like; pinnae c. 12 pairs, well spaced; lower pinnae narrowed towards their bases; middle pinnae with truncate bases, upper ones broadly cuneate; aerophores not elongate. *Rachis* covered throughout with slender light brown hairs 1–1.5 mm long. *Largest pinnae* 20–30 cm long, 2.5–3.8 cm wide, acuminate with cauda

1–3 cm long; edges lobed  $\frac{1}{4}$ – $\frac{1}{3}$  to costa, lobes falcate with forward-pointing obtuse tips; costules 4.5–6 mm apart; veins to 11 pairs,  $1\frac{1}{2}$ –2 pairs anastomosing, next 2 pairs to sides of long sinus-membrane; lower surface of costae covered with erect hairs 0.5–1 mm long, shorter hairs on costules, veins and between veins, some glands with the hairs on costules and veins; upper surface of costae covered with fine pale antrorse hairs, on costules and veins much shorter hairs with scattered long ones, surface between veins glabrous or with suberect hairs. *Sori* medial, about twice as long as wide; indusia large, thin, bearing slender hairs and glands; sporangia bearing neither glands nor setae on body, hair on stalk of several cells, terminal one acicular and thick-walled; spores with many small wings.

Distr. *Malesia*: Malaya, Sumatra, Borneo.

Ecol. In forest at 50–1000 m.

Note. v.A.v.R. distinguished var. *borneensis* which has many glands and no hairs on indusia. His *M. sumatrensis* was based on a rather small specimen. Glands are apparently sometimes lacking on lower surface of costules.

**105. *Sphaerostephanos loherianus* (CHRIST) HOLTUM**, Kalikasan 4 (1975) 61. — *Aspidium loherianum* CHRIST, Bull. Herb. Boiss. 6 (1893) 191. — *Dryopteris loheriana* (CHRIST) C. CHR. Ind. Fil. (1905) 275; CHRIST, Philip. J. Sci. 2 (1907) Bot. 207; v.A.v.R. Handb. (1908) 221, 820. — *Cyclosorus loherianus* (CHRIST) COPEL. Gen. Fil. (1947) 142; Fern Fl. Philip. (1960) 342. — *Thelypteris loheriana* (CHRIST) REED, Phytologia 17 (1968) 289. — Type: LOHER 900, Luzon, Montalban, Oct. 1890 (P; K).

*Caudex* creeping, sometimes with well-spaced fronds. *Stipe* 5–30 cm long, reddish, glabrescent; base of stipe to first large pinna 40–50 cm. *Reduced pinnae* 5–15 pairs, deflexed, strongly auricled, uppermost 6–10 mm long, lowest 2–5 mm. *Lamina* to 60 cm or more long; pinnae well spaced, several lower pairs narrowed towards their bases; aerophores slightly swollen. Lower surface of *rachis* densely covered with short erect hairs, those on upper surface to 1 mm long. *Suprabasal pinnae* of type 11 × 1.8 cm, of largest specimen 30 × 3.2 cm; basal lobes somewhat reduced; apex acuminate, sometimes with cauda to 2 cm; edges lobed to 2 mm from costa, lobes slightly falcate, narrowed gradually from base; costules 4–4.5 mm apart, almost at right angles to costa; veins of type to 14 pairs, of largest specimen 24 pairs, basal veins near base of pinna often anastomosing to form a short excurrent vein, those near apex of pinna connivent at the sinus without uniting; lower surface of costae densely covered with erect hairs 0.3–0.5 mm long, on some specimens to 1 mm, on costules and veins shorter hairs and some glands, short erect hairs between veins; hairs on upper surface of costae to 1 mm

long, scattered similar hairs on costules and veins, between veins a variable number of short hairs. *Sori* all close to margin; indusia small, covered with short hairs and sometimes a few glands; sporangia setiferous, rarely with a gland.

Distr. *Malesia*: Philippines (N. Luzon).

Ecol. In mountain forest, 1500–2000 m; smaller specimens apparently from streamsides in open places.

**106. *Sphaerostephanos erectus* (COPEL.) HOLT-TUM**, *Kalikasan* 4 (1975) 64. — *Cyclosorus erectus* COPEL. *Philip. J. Sci.* 81 (1952) 30, t. 22; *Fern Fl. Philip.* (1960) 346. — *Thelypteris erecta* (COPEL.) REED, *Phytologia* 17 (1968) 275. — Type: RAMOS BS 41550, Leyte, Cabalian (US; B).

*Caudex* slender, erect, to 100 cm tall. *Stipe* 10 cm long, reddish, minutely hairy; base of stipe to first large pinna 45 cm. *Reduced pinnae* to at least 6 pairs, uppermost 5 mm long. *Lamina* to 50 cm long; pinnae 15 pairs, lower ones narrowed on basiscopic side near base; apex of frond narrowly triangular and deeply lobed with abrupt transition to pinnae; aerophores not elongate. Hairs on *rachis*, both sides, to 1 mm long, thick, brown. *Suprabasal pinnae* to 14 × 2.8 cm; base truncate; apex rather abruptly caudate-acuminate; edges lobed 3/5–2/3 to costa, lobes falcate; costules 4–5.5 mm apart, at more than 60°; veins 10–12 pairs, prominent on lower surface, basal pair anastomosing, second pair touching sides of sinus-membrane; hairs on lower surface of costae spreading, of varied length to 1 mm, on costules shorter with glands; hairs on upper surface of costae 1 mm long, on costules short, sometimes with a few glands, rest of upper surface glabrous. *Sori* medial; indusium firm, large, short-hairy; sporangia bearing glands.

Distr. *Malesia*: Philippines (Leyte, 2 collections; Biliran).

Ecol. In mossy forest at 1000 m (M. G. PRICE 3278).

Note. M. G. PRICE informs me that SULIT PNH 20306 from Biliran, which he identifies with this species, has a few glands on upper surface of costules; I have seen none in this position on the specimens from Leyte.

**107. *Sphaerostephanos stresemannii* HOLT-TUM**, *sp. nov.*

*Basis frondis imperfecta; pinnae infimae 12 cm longae, medio 3.2 cm latae, basin versus angustatae; pinnae suprabasales usque 10 × 2.7 cm, oppositae, 3/4 costam versus lobatae; costae subtus pilis erectis usque 0.5 mm longis vestitae, costulae venaque pilis sparsis glandulisque praeditae; pagina superior inter venas pilis brevibus suberectis instructa; sori exindusiati; sporangia setifera.* — Type: STRESEMANN 416, Moluccas, Buru, G. Fogha 1400 m (L).

*Caudex* and *stipe* lacking. *Reduced pinnae* at

least 2 pairs, 3–4 mm long; above them are an intermediate unequal pair 1.0 and 2.0 cm long. *Lamina* 42 cm long; apex narrowly deltoid with gradual transition to upper pinnae; pinnae 15 pairs, almost opposite; basal pinnae largest, 12 × 3.2 cm, widest in middle and narrowed to base both sides, basiscopic lobes longer than acroscopic; aerophores swollen, not elongate. Hairs on lower surface of *rachis* dense, short, erect, with scattered longer ones to 0.7 mm, hairs on upper surface longer and appressed. *Suprabasal pinnae* to 10 × 3.0 cm; base truncate; apex short-acuminate; edges lobed fully 3/4 to costa, lobes hardly falcate, slightly tapered; costules 4.5 mm apart at more than 60°; veins 10 pairs, slender, pale both sides, 1 pair anastomosing, next acroscopic veins to side of short sinus-membrane; hairs on lower surface of costae as on rachis, on costules and veins more sparse and shorter spreading hairs with glands; short erect hairs on surface between veins; hairs on upper surface of costae more than 0.5 mm long, similar hairs scattered on costules and veins, between veins short suberect hairs. *Sori* medial; indusia lacking; sporangia copiously setose; spores with many small wings.

Distr. *Malesia*: Moluccas (Buru), 1400 m.

**108. *Sphaerostephanos simplicifolius* (J. SM. ex HOOK.) HOLT-TUM**, *Kalikasan* 4 (1975) 61. — *Aspidium simplicifolium* J. SM. ex HOOK. *IC. Pl.* 10 (1854) t. 919. — *Polypodium simplicifolium* (J. SM.) HOOK. *Sp. Fil.* 5 (1863) 2, excl. SEEMANN 736 (Fiji). — *Dryopteris canescens* var. C. CHR. *Ind. Fil.* (1905) 256. — *Dryopteris simplicifolia* (J. SM.) CHRIST, *Philip. J. Sci.* 2 (1907) Bot. 206. — *Phegopteris simplicifolia* (J. SM.) v.A.v.R. *Handb.* (1908) 500. — *Cyclosorus simplicifolius* (J. SM.) COPEL. *Gen. Fil.* (1947) 143; *Fern Fl. Philip.* (1960) 371. — *Thelypteris simplicifolia* (J. SM.) REED, *Phytologia* 17 (1968) 314. — Type: CUMING 315, Samar (K; E, G, L).

*Caudex* short-creeping; *stipe* to 20 cm long, pale; basal scales 7 × 1 mm; base of stipe to first normal pinna 40–50 cm; *reduced pinnae* to 6–7 pairs, lowest 3 mm long, uppermost 10 mm, triangular with asymmetric base. *Lamina* to 50 cm long; apex pinna-like, pinnae to 8 pairs, lowest somewhat narrowed at base; aerophores not elongate. Hairs on both sides of *rachis* pale, longest more than 1 mm rather sparse, with shorter ones. *Largest pinnae* to 16 × 4 cm; base broadly cuneate, not auricled; apex abruptly short-acuminate; edges crenate to subentire; costules 4–4.5 mm apart, at 60°; veins to 10 pairs, pale and prominent on lower surface, almost all anastomosing to produce a zig-zag excurrent vein; copious stiff short erect hairs on lower surface of costae with scattered long ones, on costules and veins fewer short hairs and also glands; hairs on upper surface of costae and costules short with scattered long ones. *Sori* near apices of veins,

basal ones on veins from adjacent costules sometimes confluent; indusia with many short hairs; sporangia with many glands; spores with many broad translucent wings which anastomose.

Distr. *Malesia*: Philippines (Samar, Leyte, Biliran).

Note. The original description was based on a partially fertile small plant with apical lamina much larger than the pinnae. The above description is based on fully grown plants from other collections. Both the type and larger specimens have glands on sporangia, not setae as stated by COPELAND. In Sp. Fil. vol. 5 HOOKER misidentified a specimen of the exindusiate *Pronephrium beccarianum* (from Fiji) with the present species, for which reason he transferred the latter to *Polypodium*.

**109. *Sphaerostephanos spenceri* (CHRIST) HOLTUM**, *Kalikasan* 4 (1975) 58. — *Dryopteris spenceri* CHRIST, *Philip. J. Sci.* 2 (1907) Bot. 206; v.A.v.R. *Handb. Suppl.* (1917) 188. — *Phegopteris spenceri* (CHRIST) v.A.v.R. *Handb.* (1908) 508. — *Cyclosorus spenceri* (CHRIST) COPEL. *Gen. Fil.* (1947) 143; *Fern Fl. Philip.* (1960) 350. — *Thelypteris spenceri* (CHRIST) REED, *Phytologia* 17 (1968) 314. — Type: COPELAND 1464, Mindanao, Davao Distr., Todaya (P; B, US).

*Caudex* short, suberect or creeping. *Stipe* 5–10 cm long, densely short-hairy; base of stipe to first large pinna 35 cm. *Reduced pinnae* to at least 10 pairs, lowest 5–10 mm long, uppermost to 2 cm long, 1.5 cm wide above auricled acroscopic base, triangular, crenate. *Lamina* 45 cm long; apex narrowly triangular, deeply lobed at base; pinnae to at least 10 pairs; basal pinnae not narrowed at base; aerophores not elongate. Hairs on both sides of *rachis* dense, c. 0.3 mm long, with some less abundant 1 mm or a little more. *Largest pinnae* 8.5 × 2.0 cm; base broadly rounded to subcordate on basiscopic side, truncate to broadly cuneate on acroscopic; apex short-acuminate; edges crenate to a depth of 1 mm or a little more; costules 4½–5 mm apart, at 60°; veins 7–8 pairs, prominent on lower surface, 2–2½ pairs anastomosing to form a zig-zag excurrent vein, 2–2½ pairs passing to sides of sinus-membrane; *lower surface* of costae hairy as rachis, hairs on costules shorter with some glands, short erect hairs on surface between veins; hairs on *upper surface* of costae 0.3–0.4 mm long, on costules shorter. *Sori* medial, distinctly elongate; indusia with short hairs; sporangia bearing glands.

Distr. *Malesia*: Philippines (E. & S.E. Mindanao).

Note. CHRIST failed to see the indusia and thus at first misled v.A.v.R. The short stipe and deeply lobed apical lamina appear to be distinctive and are shown by M. G. PRICE 2790 from Agusan del Sur Province, which is a rather small sterile plant differing from the type in scattered long

hairs on the upper surface of costules and veins and in abundant glands on lower surface of costules and veins.

**110. *Sphaerostephanos mengienianus* HOLTUM**, *sp. nov.*

*Caudex* 40 cm longus, erectus; *pinnae omnes oppositae, basi late cuneatae; pinnae redactae 8-jugatae, maximae 2 × 2 cm; pinnae normales 13.5 × 2.0 cm, crenatae; pili paginae inferioris omnes breves; costulae subtus glanduliferae; indusia pilifera; sporangia glandulifera? (non setifera)*. — Type: STEVENS & LELEAN LAE 58680, E. New Britain, in *Castanopsis* forest, 900 m (K; L).

*Caudex* erect, 50 cm tall (collectors). *Stipe* 15 cm long, minutely hairy, dull reddish; base of stipe to first large pinna 60 cm. *Reduced pinnae* opposite, 5–6 cm apart, lowest 7 mm long, uppermost 2 × 2 cm, almost symmetrically rhombic with basal angle more than 90°, apical angle less than 90°, subentire; one pair intermediate pinnae 4 cm long also present. *Lamina* 55 cm long; apex not pinna-like; pinnae 20 pairs, all opposite; basal pinnae not narrowed at base; aerophores not elongate. Hairs on lower surface of *rachis* 0.2 mm long, slender, appressed, on upper surface thicker, antorsely curved, 0.5 mm long. *Largest pinnae* 13.5 × 2.0 cm; base broadly cuneate and slightly dilated both sides; apex acuminate, not caudate; edges crenate to a depth of 1.5 mm or little more; costules 4.5–5 mm apart, at less than 60°; veins 7–8 pairs, 2–2½ pairs anastomosing to form a zig-zag excurrent vein, 1½–2 pairs passing to rather long sinus-membrane; *lower surface* of costae covered with slender appressed hairs 0.2 mm long, similar sparse hairs with glands on costules, surface between veins glabrous, eglandular; hairs on *upper surface* of costae 0.5 mm long, rest of upper surface glabrous. *Sori* medial; indusia rather small, thin, with short hairs; sporangia probably with glands, not setiferous.

Distr. *Malesia*: Papua New Guinea (New Britain), only the type.

Ecol. In *Castanopsis* forest, 900 m.

**111. *Sphaerostephanos confertus* (BRAUSE) HOLTUM**, *Webbia* 30 (1976) 194. — *Dryopteris conferta* BRAUSE, *Bot. Jahrb.* 49 (1912) 22, f. 1F; v.A.v.R. *Handb. Suppl.* (1917) 175. — *Cyclosorus confertus* (BRAUSE) COPEL. *Gen. Fil.* (1947) 142; HOLTUM & ROY, *Blumea* 13 (1965) 134. — *Thelypteris conferta* (BRAUSE) REED, *Phytologia* 17 (1968) 268. — Type: SCHLECHTER 17864, N.E. New Guinea, Rani Mts 700 m (B; K, L, P, UC).

*Dryopteris terrestris* COPEL. *Univ. Cal. Publ. Bot.* 18 (1942) 221. — *Cyclosorus terrestris* (COPEL.) COPEL. *Gen. Fil.* (1947) 143; *Philip. J. Sci.* 78 (1951) 454, pl. 34. — *Thelypteris terrestris* (COPEL.) REED, *Phytologia* 17 (1968) 319. —

Type: BRASS 13660, New Guinea, Idenburg River, in forest at 700 m (MICH; BO, L).

*Caudex* short, creeping, branched, apices of branches with tufts of fronds. *Stipe* 5–15 cm long, minutely hairy; basal scales narrow, firm; base of stipe to first large pinna 15–30 cm. *Reduced pinnae* 5–6 pairs, uppermost 6–12 mm long and wide, broadly triangular, lowest 3–5 mm long. *Lamina* 30–40 cm long; apex deltoid, deeply lobed; pinnae to 15 pairs, basal ones slightly narrowed at base which in some cases is slightly auricled; aerophores not elongate. Lower surface of *rachis* covered with short erect pale hairs; upper surface with long curved brown hairs and shorter ones in the groove. *Largest pinnae* 5–10 cm long, 1.5–2.0 cm wide, in some cases widest 1/3 from apex; base truncate, in some cases a little dilated both sides or only on acroscopic side; apex abruptly short-acuminate, with or without a short cauda; edges crenate throughout (near apex only in small pinnae) to a depth of 1–2 mm; costules commonly 4 mm apart, at 60°; veins 5–6 pairs, 2 pairs anastomosing to form a zig-zag excurrent vein, 1–2 pairs to rather long sinus-membrane; lower surface of costae covered with antrorse (not closely appressed) hairs 0.1–0.3 mm long, hairs on costules and veins sparse, sometimes with a few glands, short erect hairs on surface between veins; hairs on upper surface of costae 0.3–0.4 mm long, a few minute hairs on costules, between veins a variable number of short appressed hairs. *Sori* medial; indusia with many short stiff hairs; sporangia bearing several setae, sometimes also a gland; spores minutely papillose.

Distr. *Malesia*: New Guinea and Waigeo; at low altitudes in forest.

Note. Many collections from eastern New Guinea, none from west except Waigeo.

**112. *Sphaerostephanos multiauriculatus* (COPEL.) HOLTUM, comb. nov.** — *Dryopteris multiauriculata* COPEL. Univ. Cal. Publ. Bot. 18 (1942) 221. — *Cyclosorus multiauriculatus* (COPEL.) COPEL. Gen. Fil. (1947) 143; Philip. J. Sci. 78 (1951) 453, pl. 32. — *Thelypteris multiauriculata* (COPEL.) REED, Phytologia 17 (1968) 294. — Type: BRASS 12850, New Guinea, Idenburg River, 1150 m, in gullies in forest (MICH; BM, L).

*Caudex* erect, to 40 cm tall, 1.5 cm diameter. *Stipe* 5–10 cm long, reddish, minutely hairy, with many narrow scales 10 mm long. *Lamina* 150 cm long, somewhat dimorphous; pinnae to 45 pairs, lower 12–15 pairs gradually reduced, lowest 1 cm long, suprabasal ones spreading, broadly triangular with symmetric base; aerophores elongate barely to 1 mm. Lower surface of *rachis* of fertile frond densely covered with short appressed hairs, hairs on upper surface similar but with some thick brown hairs 1.5 mm long; similar long thick hairs sometimes present on lower surface of sterile fronds. *Largest sterile pinnae* to 15 × 1.8 cm; base

subtruncate; apex short-acuminate, not caudate; edges crenate to a depth of 1 mm; costules 3 mm apart, at 60°; veins to 7 pairs, slender and prominent both sides, 3–3½ pairs anastomosing to form a zig-zag excurrent vein, 1 pair to very short sinus-membrane; lower surface of costae, costules and veins covered with appressed hairs 0.1–0.3 mm long, a few similar hairs on surface between veins, glands lacking; upper surface of costae covered with hairs less than 0.5 mm long, rest of surface glabrous. *Fertile pinnae* to 9 × 1.0 cm; sori medial, often spreading a little along veins; no indusia; sporangia sometimes bearing a few glands, not setae.

Distr. *Malesia*: Eastern New Guinea at 750–1220 m.

**113. *Sphaerostephanos stipellatus* (BL.) HOLTUM, comb. nov.** — *Aspidium stipellatum* BL. Enum. Pl. Jav. (1828) 152; MIQUEL, Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 160. — *Nephrodium stipellatum* (BL.) MOORE, Ind. Fil. (1858) 105; RACIB. Fl. Btzig 1 (1898) 188. — *Dryopteris stipellata* (BL.) O. KTZE, Rev. Gen. Pl. 2 (1891) 813; v.A.v.R. Handb. (1908) 227; BACKER & POSTH. Varenfl. Java (1939) 49. — *Thelypteris stipellata* (BL.) K. IWATS. Acta Phytotax. Geobot. 21 (1965) 168. — Type: BLUME, Java (L, n. 908, 337–123).

*Caudex* thick, short-creeping, apex and very young fronds covered with slime. *Stipe* 10 cm long, glabrescent; scales very thin; base of stipe to first large pinna 65 cm. *Reduced pinnae* 2–3 cm apart, to 15 pairs or more, lowest 6 mm long, uppermost 12 mm long, deflexed, narrowly triangular and strongly auricled. *Lamina* to 70 cm long; pinnae to 30 pairs, lower ones not narrowed at their bases; aerophores thick, to 2 mm long. Hairs on lower surface of *rachis* of fertile fronds 0.3 mm long, closely appressed, on sterile ones sparse longer hairs also; on upper surface pale, spreading, 1 mm long. *Largest pinnae* commonly 12 × 1.8 cm; base subtruncate; apex acuminate, apical 1.5 cm entire; edges lobed c. 1/3 to costa (always less than ½), lobes of fertile fronds distinctly falcate; costules 3.5–4.5 mm apart, at a wide angle; veins 6–8 pairs, 1 pair anastomosing, next acroscopic vein to side of short sinus-membrane; hairs on lower surface of costae and costules short, closely appressed, with a few longer ones distally on costae, few or none on veins and surface between them, no glands; hairs on upper surface of costae 1 mm long, scattered similar hairs on costules and veins. *Sori* medial; indusia firm, with a few glands; sporangia bearing glands; spores finely spinulose.

Distr. *Malesia*: Java, Sumatra.

Ecol. In forest at 1000–1700 m.

**114. *Sphaerostephanos plurifolius* (v.A.v.R.) HOLTUM, comb. nov.** — *Dryopteris plurifolia*



v.A.v.R. Bull. Jard. Bot. Btzig III, 5 (1922) 201. — *Thelypteris plurifolia* (v.A.v.R.) REED, Phytologia 17 (1968) 305. — Type: LÖRZING 6393, Sumatra, Deli, Bandar-baroe, 800 m (BO).

*Caudex* erect, 20–30 cm tall, apex and young fronds covered with mucilage; *stipe* 10–15 cm long; base of stipe to first normal pinna 40–50 cm; *reduced pinnae* c. 4 cm apart, to 8 pairs, lowest very small, upper ones 6 mm long. *Lamina* 70 cm or more long; pinnae to 25 pairs, 3 or more pairs of lower ones distinctly narrowed towards their bases, basal ones much narrowed; aerophores to 2 mm long. Hairs on lower surface of *rachis* very short, erect, on upper surface 0.5 mm long, or to 1 mm on sterile fronds. *Largest suprabasal pinnae* commonly 15 × 2 cm (sterile to 25 × 3.2 cm); base truncate; apex acuminate; edges lobed 2/3–3/4 towards costa, lobes falcate; costules 3.5–5 mm apart, at more than 60° to costa; veins 10–13 pairs, basal pair anastomosing, next pair both passing to margin or the acroscopic vein to sinus-membrane; lower surface of costae, costules and veins covered with short pale appressed hairs, without glands, area between veins glabrous; hairs on upper surface of costae short, with some longer ones, similar long hairs scattered on costules and veins. *Sori* medial; indusia large, firm, with a few hairs; sporangia usually bearing glands.

*Distr. Malesia*: Sumatra.

*Note*. The type has distinctly dimorphous fronds, but a specimen from Gunung Kerinci (ROBINSON & KLOSS s.n. at BM) has fertile pinnae to 3.2 cm wide.

**115. *Sphaerostephanos hendersonii* HOLTUM, sp. nov.**

*Pinnae redactae* c. 8-jugatae, usque 6 mm longae; *pinnae normales* usque 14 × 2.3 cm, 3/5 costam versus lobatae, basi aerophoris longis praeditae, subtus eglandulosae; *venae* 10-jugatae, infimae solum anastomosantes; *rachis*, *costae* costulaeque subtus pilis adpressis vestitae; *sori mediales*; *indusia parva, tenuia, sparsim pilosa*; *sporangia glandulifera*. — Type: HENDERSON 23352, Malaya, Cameron Highlands, 1500 m (K; SING).

*Caudex* short, erect or suberect; *stipe* 10–15 cm long; base of stipe to first normal pinna 40–50 cm; *reduced pinnae* c. 4 cm apart, c. 8 pairs, uppermost 6 mm long, rest very small. *Lamina* excluding reduced pinnae 70 cm long; pinnae more than 20 pairs; basal pinnae narrowed towards their bases which are 1.2 cm wide; aerophores to almost 2 mm long. *Largest pinnae* (fertile) 14 × 2.3 cm; base truncate; apex abruptly short-acuminate with narrow entire cauda 1–2 cm long; edges lobed to 4 mm from costa; costules 4–5 mm apart, at more than 60°; veins to 10 pairs, basal pair anastomosing, next acroscopic vein passing to the sinus-membrane, sometimes a basicopic vein also; lower surface of *rachis* bearing slender ap-

pressed pale hairs 0.2 mm long (sometimes sparse), costae and costules bearing many appressed hairs 0.3–0.4 mm long, on and between veins neither hairs nor glands; upper surface of *rachis* bearing pale curved hairs 0.5 mm long, hairs on costae to 1 mm or more, similar hairs rare on costules and veins, surface between veins bearing a variable number of appressed hairs. *Sori* medial, basal ones not divergent; indusia small, thin, with a few hairs; sporangia bearing glands.

*Distr. Malesia*: Malaya (Cameron Highlands, 3 collections); N. Sumatra at 1700 m.

*Note*. The Sumatran specimens (SURBECK 747, 1201) are somewhat smaller than those from Malaya, with pinnae lobed a little less deeply, and have a seta on some sporangia.

**116. *Sphaerostephanos posthumii* HOLTUM, sp. nov.**

*Pinnae redactae* c. 10-jugatae, usque 4 mm longae; *pinnae normales* usque 12.5 × 1.5 cm, basi aerophoris 1 mm longis praeditae, profunde lobatae; *venae infimae prope sinum conniventes, vel liberae vel anastomosantes*; *pagina inferior pinnarum eglandulosa, pagina superior pilis adpressis vestita*; *indusia parva, brevi-pilosa*; *sporangia glandulifera*. — Type: POSTHUMUS 3157, Flores, near Sita, 600–700 m (BO).

*Caudex* not known; *stipe* 24 cm long, basal scales broad, thin, with rather long superficial hairs; base of stipe to first normal pinna 80 cm; *reduced pinnae* c. 5 cm apart, uppermost 4 mm long. *Lamina* 60 cm long, excluding reduced pinnae; pinnae 20 pairs; lowest large pinnae much narrowed towards their bases, several successive pairs gradually less narrowed; aerophores 1 mm long. *Rachis* on both surfaces covered with pale appressed hairs c. 0.6 mm long. *Largest pinnae* (fertile) 12.5 × 1.5 cm, sessile; apex gradually attenuate, not caudate; edges lobed to 1.5–2 mm from costa, lobes slightly falcate; costules 3–3½ mm apart, at 60°; veins 10–12 pairs, basal pair either both touching sides of a short sinus-membrane or meeting just below it to form a short excurrent vein; lower surface of costae and costules closely covered with pale appressed hairs, between veins some shorter appressed hairs, glands lacking; upper surface throughout covered with pale appressed hairs 0.3–0.4 mm long. *Sori* a little inframedial, basal ones not much divergent; indusia rather small, thin, with many hairs 0.2 mm long; sporangia often with a gland.

*Distr. Malesia*: Lesser Sunda Is. (Flores), only known from type.

**117. *Sphaerostephanos inconspicuus* (COPEL.) HOLTUM, comb. nov.** — *Dryopteris inconspicua* COPEL. Philip. J. Sci. 12 (1917) Bot. 55; C. CHR. Gard. Bull. Str. Settl. 7 (1934) 242. — *Thelypteris inconspicua* (COPEL.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 252. — Type: TOPPING

1543, Sabah, Mt Kinabalu, Kiau (isotype NY). — Fig. 12n-p.

*Caudex* short, creeping. *Stipe* 4–8 cm long, minutely hairy; base of stipe to first large pinna 15–30 cm. *Reduced pinnae* 4–7 pairs, all very small, not opposite. *Lamina* 25–40 cm long; pinnae to 25 pairs, basal pinnae narrowed at base; aerophores not elongate. Hairs on lower surface of *rachis* variable, sometimes very few on fertile fronds, on sterile often many, thick, curved, 0.5 mm or more long; hairs on upper surface 0.8–1.0 mm long. *Largest pinnae*  $3.5 \times 0.8$  to  $6.0 \times 1.3$  cm; base subtruncate; basal acroscopic lobe sometimes elongate; apex acuminate, sometimes caudate; edges lobed to 1–1.5 mm from costa, lobes oblique; costules 3–3.5 mm apart, usually at less than 60°; veins 4–5 pairs, slender, basal acroscopic vein touching short sinus-membrane, basal basicopic vein to edge above base of sinus; hairs on lower surface of costae 0.2–0.3 mm long, pale, appressed, fewer on costules, sometimes with rudimentary scales which have a glandular tip, sessile spherical glands usually lacking; hairs on upper surface of costae less than 0.5 mm long, no others. *Sori* medial; indusia rather large with a few short hairs or glabrous; sporangia bearing a gland or a seta; spores not seen.

*Distr. Malesia:* Borneo; several localities, in forest at 1200–1800 m.

**118. *Sphaerostephanos subulifolius*** (v.A.v.R.) HOLTUM, *comb. nov.* — *Dryopteris subulifolia* v.A.v.R. Bull. Jard. Bot. Btzg II, 28 (1918) 22. — *Thelypteris subulifolia* CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 254. — Type: BROOKS 334 *partim*, Sumatra, Benkoelen, Lebong Simpang (BO; BM).

Closely allied to *S. inconspicuus*, differing as follows: reduced pinnae 2–3 pairs, all very small; normal pinnae to 30 or more pairs; pinnae abruptly short-acuminate, lobed to 1 mm from costa; hairs on lower surface of costae 0.5 mm long, not closely appressed.

*Distr. Malesia:* Southern Sumatra, 3 collections.

*Notes.* The differences between this and *S. inconspicuus* need checking from further collections from Sumatra. BROOKS 334 at BM includes specimens of *Coryphopteris hirsutipes* (CLARKE) HOLTUM.

**119. *Sphaerostephanos mjobergii*** HOLTUM, *sp. nov.*

*S. inconspicuus* (Copel.) Holttum *affinis*, differt: *pinnis evolutis* 27-jugatis, usque  $3.6 \times 1.0$  cm *metientibus*, ad *alam* 0.5 mm *latam lobatis*; *venis infimis omnibus ad marginem supra basin sinuum terminatis*; *costis subtus pilis patentibus vestitis*. — Type: E. Mjöberg s.n. Sarawak, Mt Poi, 1370–1520 m (BM).

*Caudex* and *stipe* missing. *Reduced pinnae* all

very small, 2–3 pairs on specimen. *Lamina* 30 cm long; pinnae 27 pairs; basal pinnae apparently narrowed on basicopic side only; aerophores not elongate. Hairs on lower surface of *rachis* 0.2–0.3 mm long, copious. *Largest pinnae*  $3.6 \times 1.0$  cm; base symmetric, subtruncate; apex rather abruptly acute; edges lobed to 0.5 mm from costa, lobes hardly falcate; costules to 2.5 mm apart; veins 3–4 pairs, basal ones both passing to margin above base of sinus; lower surface of costae covered with somewhat antrorse hairs 0.2–0.3 mm long, longer hairs scattered on costules; hairs on upper surface of costae short, with longer ones scattered on distal parts of costae and on costules. *Sori* inframedial; indusia sparsely hairy; sporangia bearing glands; spores with a narrow erose wing, surface otherwise bearing scattered small wings or papillae.

*Distr. Malesia:* Borneo (Sarawak), only known from the type.

**120. *Sphaerostephanos mutabilis*** (BRAUSE) HOLTUM, *comb. nov.* — *Dryopteris mutabilis* BRAUSE, Bot. Jahrb. 56 (1920) 97. — *Cyclosorus mutabilis* (BRAUSE) COPEL. Gen. Fil. (1947) 143; Philip. J. Sci. 78 (1951) 443. — *Thelypteris mutabilis* (BRAUSE) REED, Phytologia 17 (1968) 295. — Type: LEDERMANN 9745, N.E. New Guinea, Sepik Distr., on rocks, 200–400 m (B; UC).

*Caudex* short, erect. *Stipe* 5–8 cm long, reddish, glabrous; scales  $c. 2 \times 1$  mm. *Lamina* to 20 cm long; apex pinna-like; pinnae 10 pairs, lower 3–4 pairs gradually smaller, lowest 5–10 mm long; aerophores not elongate. *Largest pinnae* commonly  $6 \times 0.3$  cm (to  $8.5 \times 0.5$  cm, *fide* BRAUSE); base and apex narrowly attenuate, edges entire; costules 1.5 mm apart, very oblique, forked or simple, without anastomosis; lower surface quite glabrous; upper surface hairy in groove of rachis only. *Sori* in one row on each side of costa, often on both branches of a costule; indusia large, firm, with a few glands; sporangia sometimes bearing glands; spores minutely spinulose.

*Distr. Malesia:* New Guinea. Known only from type and BRASS 13047 from Idenburg River.

*Ecol.* In forest, “massed in semi-shade on steep flood-swept bank of river” (BRASS), 200–850 m.

**121. *Sphaerostephanos uaniensis*** HOLTUM, *sp. nov.*

*Stipes* 5 cm *longus*; *pinnae redactae* 3–4-jugatae; *lamina* 33 cm *longa*, *pinnae normales* 12-jugatae, *superiores plures non liberae*; *pinnae liberae subintegrae, basi auriculatae*; *costae subtus pilis erectis* 0.1–0.2 mm *longis vestita*, *pagina inferior cetera pilis brevioribus praedita*, *eglandulosa*; *sori elongati*; *indusia parva (vel nulla?)*; *sporangia interdum glandula una praedita*. — Type: T. G. WALKER 10132, cult. Kew, origin New Britain, Uani River (BM).

*Stipe* 5 cm long; *lamina* in all 33 cm long, consisting of 3 pairs of reduced pinnae (basal one 7×5 mm with stalk 1.5 mm, uppermost 1.2×0.6 cm with auricled base), 1 intermediate pair (unequal) 2.0 and 2.7 cm long, and 12 pairs normal pinnae of which several upper ones are adnate to the rachis. *Largest pinnae* 4.2 cm long, 1.4 cm wide at the auricled base, 1.1 cm wide above base; apex rather abruptly obtuse; edges irregularly sinuous; costules 2.5–3 mm apart, at c. 45°; veins 3 pairs, 2 pairs anastomosing, slender, concolorous; *lower surface* of rachis bearing sparse stiff curved pale hairs 0.2–0.3 mm long, costal hairs 0.1–0.2 mm, erect, very short hairs on costules and on surface between veins, no glands; *upper surface* hairy only on costae and rachis. *Sori* all considerably elongate, those on basal veins of adjacent costules almost meeting, distal ones shorter and near costules; indusia very small with 2 or 3 short hairs, apparently sometimes lacking; sporangia not setiferous, sometimes with a gland.

Distr. *Malesia*: New Guinea (New Britain), only known from type.

**122. *Sphaerostephanos echinosporus*** (v.A.v.R.) HOLTUM, *comb. nov.* — *Dryopteris echinospora* v.A.v.R. Bull. Jard. Bot. Btzig III, 2 (1920) 149. — *Thelypteris echinospora* (v.A.v.R.) REED, Phytologia 17 (1968) 274. — Type: BROOKS 451, Sumatra, Seblat River, Benkoelen (BO; BM).

*Caudex* not known; *stipe* 5 cm long; base of *stipe* to largest pinna 80 cm; *reduced pinnae* c. 15 pairs, uppermost (v.A.v.R.) 6×1 cm, a middle one seen 4.5 cm long, 7 mm wide in the middle and gradually narrowed towards auricled base, lobed half-way to costa, one near base 1.8 cm long, 2 mm wide apart from a narrow basal auricle. *Lamina* excluding reduced pinnae 100 cm long; basal pinnae narrowed towards their bases which have a narrow auricle 6 mm long, upper pinnae truncate to full width at base; aerophores to 2 mm long. *Largest pinnae* 16×2.1 cm; apex narrowly caudate and entire; edges lobed to 2 mm from costa; lobes slightly falcate, separated by wide sinuses; costules 3.5–4 mm apart; veins to 11 pairs, basal pair, at a wide angle to costule, anastomosing to form a short excurrent vein, next pair both to margin above base of sinus; *lower surface* of costae densely covered with hairs 0.2–0.3 mm long, hairs on costules more sparse and somewhat antrorse, sparse minute erect hairs present between veins, no glands; *upper surface* of costae covered with antrorse hairs 0.6 mm long, rest of surface covered with slender appressed hairs 0.3 mm long. *Sori* medial, covering lower surface of pinna-lobes at maturity; indusia large, firm, with sparse short hairs; a small proportion of sporangia bearing a single seta or (less commonly?) a gland.

Distr. *Malesia*: South Sumatra. Known only

from the type; "common" at the type locality.

**123. *Sphaerostephanos peltoclamys*** (C. CHR.) HOLTUM, *comb. nov.* — *Dryopteris peltoclamys* C. CHR. Dansk Bot. Ark. 9, 3 (1937) 65; BACKER & POSTH. Varenfl. Java (1939) 338, *excl. syn.* — *Abacopteris peltoclamys* (C. CHR.) HOLTUM, Rev. Fl. Mal. 2 (1955) 295, f. 171. — *Thelypteris peltoclamys* (C. CHR.) REED, Phytologia 17 (1968) 303. — Type: C. W. FRANCK s.n. E. Java, Tanggore (BM).

*Nephrodium urophyllum* *sensu* RACIB. Fl. Btzig 1 (1898) 184.

*Caudex* a short or long-creeping rhizome. *Stipe* 20–30 cm long, glabrous, stramineous; scales broad, thin; base of *stipe* to first large pinna 30–60 cm (longest on fertile fronds). *Reduced pinnae* 2–4 pairs (lacking on young plants), less than 5 mm long. *Lamina* to 60 cm long; apex pinna-like or with one basal lobe; pinnae 6–10 pairs, lower ones sometimes a little reduced, always with a narrowed base; aerophores not swollen. Lower surface of *rachis* glabrous; upper surface with short hairs in groove. *Largest pinnae* of type 21×3.5 cm; sterile pinnae to 4.5 cm wide, fertile ones on small plants 14×2.8 cm; suprabasal pinnae widest at or above the middle, slightly and gradually narrowed to an abruptly contracted broadly cuneate base; apex abruptly short caudate-acuminate; edges entire to crenate; costules 4 mm apart, at 60°; veins 7–10 pairs, almost all anastomosing to form a zig-zag excurrent vein; sinus-membrane only distinct where margin is crenate; *lower surface* quite glabrous; between veins ± verrucose when dry; *upper surface* of costae with slender hairs 0.3 mm long. *Sori* medial or somewhat inframedial; indusia large, thin, glabrous, rarely with hairs or a few glands; sporangia often bearing glands; spores with a continuous translucent wing and several other separate small wings.

Distr. *Burma*, in *Malesia*: Malaya (one collection in Kelantan), Sumatra and Java (many localities), in lowland forest.

Note. Apart from the reduced pinnae, this is very similar to *Pronephrium lineatum* (BL.) PRESL. It seems uniform over a wide area, and may be a tetraploid of hybrid origin.

**124. *Sphaerostephanos irayensis*** (COPEL.) HOLTUM, *comb. nov.* — *Cyclosorus irayensis* COPEL. Philip. J. Sci. 81 (1952) 28; Fern Fl. Philip. (1960) 340. — *Thelypteris irayensis* (COPEL.) REED, Phytologia 17 (1968) 285. — *Plesioneuron irayense* (COPEL.) HOLTUM, Blumea 22 (1975) 239. — Type: RAMOS BS 80344, Batanes Islands, Mt Iraya (MICH; SING).

*Sphaerostephanos fenixii* HOLTUM, Kalikasan 4 (1975) 55. — Type: FENIX BS 3780, Batanes Islands (P; US).

*Caudex* short-creeping; *stipe* 35–70 cm long,

glabrescent, reddish. *Lamina* 35–40 cm long; pinnae to 15 pairs, of firm texture; 1 pair reduced basal pinnae 1.5 cm long sometimes present; lowest pinnae variably narrowed towards base with stalk 1 mm long, to 2.5 cm wide at the middle; aerophores not elongate. Lower surface of *rachis* densely short-hairy. *Suprabasal fertile pinnae* to 12 × 2.2 cm (sterile to 2.8 cm wide); base broadly cuneate to full width; apex acuminate; edges lobed more than 1/2 way to costa, in basal sterile pinnae to more than 2/3; lobes falcate, those of basal pinnae attenuate; costules 5 mm apart, at 60° or more; veins 10–12 pairs, pale and prominent on both surfaces, basal pair always connivent below sinus, either anastomosing or touching sides of sinus-membrane without fusing; *lower surface* of costae hairy as rachis but less densely, of costules and veins sparsely, hairs longer on sterile than on fertile pinnae; *upper surface* densely short-hairy on costae, sparsely on costules. *Sori* medial, impressed on upper surface when dry, lower ones distinctly elongate; indusia small, thin, with short hairs; sporangia bearing 2–3 spherical yellow glands; spores with a narrow erose translucent wing and a few cross-wings.

Distr. *Malesia*: Philippines (Batanes Islands, 3 collections).

Note. This very interesting and isolated species needs further study. The type of *C. irayensis* resembles species of *Plesioneuron* in aspect and texture, but its glands (on sporangia), and venation and sinus-characters are unlike that genus.

**125. *Sphaerostephanos lithophyllus*** (COPEL.) HOLTUM, *comb. nov.* — *Dryopteris lithophylla* COPEL. Philip. J. Sci. 12 (1917) Bot. 57; C. CHR. Gard. Bull. Str. Settl. 7 (1934) 206, 245. — *Thelypteris lithophylla* (COPEL.) REED, Phytologia 17 (1968) 289. — Type: TOPPING 1850, Sabah, Mt Kinabalu (AFS; US).

*Caudex* short, suberect; apex covered with slime. *Stipe* 1–2 cm long, dark; base of stipe to first large pinna 20–35 cm. *Reduced pinnae* near base 1 cm apart, distally 2–3 cm, in all to at least 10 pairs, all with rigid aerophore, lower ones without a perceptible blade, upper ones 2 mm long and wide. *Lamina* to 30 cm long, red when young; pinnae 12–18 pairs, fleshy when living, thick and rigid when dried, 2–3 basal pairs slightly narrowed at base; aerophores elongate. *Rachis* flushed with red; both surfaces bearing a varied number of short pale to dark red erect hairs; upper surface deeply grooved. *Largest pinnae* 5–6.5 × 1.1 cm; base truncate; apex short-acuminate; edges lobed about 1/3 to costa, lobes rounded, their margins revolute on drying; costules to 3 mm apart; each with a small swelling at the base; veins to 8 pairs, prominent on the upper surface and not below, basal pair anastomosing, 2 pairs to sinus-membrane which is very prominent on the lower surface; *lower surface* of costae almost glabrous or

with pale short spreading hairs, some short hairs present on surface between veins; sparse hairs present on edges of groove of costa on *upper surface*, no others. *Sori* supramedial; indusia with a few short hairs and glands; sporangia bearing glands, often several; spores copiously minutely spinulose.

Distr. *Malesia*: Sabah (Mt Kinabalu).

Ecol. In wet ground in fully exposed places, often among rocks, at 1500–2000 m.

**126. *Sphaerostephanos hamiferus*** (v.A.v.R.) HOLTUM, *comb. nov.* — *Dryopteris hamifera* v.A.v.R. Bull. Jard. Bot. Btzg II, 16 (1914) 12; Handb. Suppl. (1917) 181. — *Thelypteris hamifera* (v.A.v.R.) REED, Phytologia 17 (1968) 281. — Type: MATTHEW s.n. Sumatra, G. Singgalang (BO).

*Caudex* erect. *Stipe* 12 cm long; basal scales thin, narrow; base of stipe to first large pinna 50 cm. *Reduced pinnae* at least 10 pairs, lowest 5 mm long, upper ones 1.0–1.5 cm long, spreading, narrowly triangular with auricle 5 mm long on acroscopic side, short on basiscopic; on type 1 pair intermediate pinnae also present. *Lamina* 70 cm long; pinnae 30 pairs; lowest pinnae slightly narrowed and slightly auricled at base; aerophores 1–2 mm long (at least on reduced pinnae). Hairs on lower surface of *rachis* dense, erect, to 0.5 mm long on fertile frond, mixed with many hairs 1 mm long on sterile; hairs on upper surface 0.5–1 mm long, less difference between fertile and sterile. *Largest fertile pinnae* of type 10 × 1.5 cm; base truncate; apex acuminate, not caudate; edges lobed more than 1/2 way to costa (on a larger specimen to 2/3), lobes slightly falcate; costules 3.5–4 mm apart, at more than 60°; veins 7–8(–10) pairs, basal pair anastomosing, next pair both to margin or acroscopic one to the short sinus-membrane; *lower surface* of costae hairy as rachis but hairs a little shorter, hairs on costules sparse, on fertile fronds antrorse but not closely appressed, glands absent or rare; hairs on *upper surface* of costae to 1 mm long, scattered similar hairs on costules and veins, surface between veins ± closely covered with slender appressed hairs. *Sori* medial; indusia large, firm, with short hairs; sporangia sometimes with a gland, not setiferous.

Distr. *Malesia*: Central Sumatra, at 1500 m or less.

Note. There is variability in size of fertile pinnae from 6.4 × 0.9 cm to 12 × 2.0 cm, the latter lobed fully 2/3.

**127. *Sphaerostephanos plurivenosus*** HOLTUM, *sp. nov.*

*Caudex brevis, repens*; *pinnae redactae* 20–30-jugatae, *aerophoris* 3 mm longis constitutis; *pinnae* 10-jugatae, *fertiles usque* 30 × 5.5 cm; *venae* 18–20-jugatae; *pagina inferior pinnarum glabra*; *sori exindusiati*; *sporangia nec setis nec glandulis praedita*. — Type: JERMY 4038, N.E. New

Guinea, Madang Distr., gorge below Moro (BM).

*Caudex* massive, prostrate. *Stipe* c. 5 cm long; base of stipe to first true pinna 30–50 cm. *Reduced pinnae* consisting of aerophores 3 mm long with no evident blade, 10–15 mm apart, 20–30 pairs. *Lamina* 100 cm or more long; apex pinna-like; pinnae c. 10 pairs, opposite, basal ones not or little reduced, lower ones 10 cm apart. *Rachis* reddish, glossy, quite glabrous apart from small hairs in groove of upper surface. *Largest fertile pinna* 30 × 3.5 cm (sterile to 35 × 6.5 cm) with stalk 2 mm long and stiff aerophores 1 mm; base rounded to broadly cuneate; apex acuminate with slender cauda to 3 cm long; edges parallel for most of their length, entire or slightly crenate; costules 4–4.5 mm apart, at almost 90°, falcate distally; veins 18–20 pairs, close, at a wide angle to costules (more oblique in sterile pinnae), excurrent veins mostly free, 2–3 veins from each costule passing to margin; *both surfaces* quite glabrous, eglandular. *Sori* supramedial, those on veins from adjacent costules touching or fusing, exindusiate, lower ones elongate; sporangia bearing neither glands nor setae; spores with a continuous wing of irregular width and some smaller wings. *Chromosomes*:  $n = 36$  (T. G. WALKER).

*Distr.* *Malesia*: Papua New Guinea; Madang and Morobe Districts at 1300–1700 m; additional specimens are CLEMENS 4841, Sattelberg; HOOGLAND 9094, Mt Rawlinson.

*Ecol.* HOOGLAND's specimen was from a shaded vertical limestone cliff near a creek.

**128. *Sphaerostephanos squamatellus* HOLTUM, sp. nov.**

*Pinnae* *redactae* 8-jugatae, *superiores* 3 mm longae; *pinnae normales* 2/5 *costam versus lobatae*; *aerophora elongata*; *costae costulaeque subtus pilis appressis vestitae, eglandulosae*; *pagina superior pinnarum pilis appressis vestita*; *indusia pilosa*; *sporangia setifera*. — Type: HOLTUM 56, Sabah, Mt Kinabalu, near waterfall in forest, 1900 m (K).

*Caudex* not preserved. *Stipe* 12 cm long, minutely hairy with many small scales; base of stipe to first large pinna 35 cm. *Reduced pinnae* 8 pairs, uppermost 3 mm long, with elongate aerophores. *Lamina* 40 cm long; pinnae 16 pairs, all almost opposite; basal pair of pinnae somewhat shortened and a little narrowed at base which is 0.8 cm wide. *Rachis* stramineous; lower surface covered at base with very short erect hairs and small appressed scales, distally with longer hairs and few scales; upper surface bearing brown hairs 1 mm long. *Largest pinnae* 10.5 × 1.7 cm; base broadly cuneate; apex rather abruptly short-acuminate; edges lobed about 2/5 to costa, lobes slightly falcate; costules 4–4.5 mm apart, at 60° or more; veins 7 pairs, basal pair anastomosing, 1–1½ pairs passing to sinus-membrane which is not prominent on the lower surface; *lower surface* of

*costae* covered with slender appressed hairs 0.3 mm long, costules and veins the same with minute uniseriate scales, appressed hairs 0.3 mm long scattered on surface between veins; hairs on *upper surface* of costae 0.7 mm long, rest of upper surface bearing slender appressed hairs 0.3 mm long. *Sori* medial; indusia firm with a few short hairs; sporangia all with 2–4 short setae.

*Distr.* *Malesia*: Sabah (Mt Kinabalu) (also CLEMENS 32548A at 2450 m, BO, L).

**129. *Sphaerostephanos canescens* (BL.) HOLTUM, comb. nov.** — *Polypodium canescens* BL. Enum. Pl. Jav. (1828) 133. — *Gymnogramme canescens* (BL.) BL. Fl. Jav. Fil. (1829) 93, t. 40. — *Phegopteris canescens* (BL.) METT. Ann. Mus. Bot. Lugd.-Bat. 1 (1864) 223 (non METT. 1858); v.A.v.R. Handb. (1908) 507, excl. var. *omn.* — *Dryopteris canescens* (BL.) C. CHR. Ind. Fil. (1905) 250, *quoad typus tantum*; BACKER & POSTH. Varenfl. Java (1939) 56. — *Haplodictyum canescens* (BL.) CHING, Sunyatsenia 5 (1940) 251. — Type: REINWARDT, Moluccas, Tidore (L, n. 908, 300–133).

*Caudex* short, creeping. *Stipe* 9–12 cm long, densely short-hairy in groove; base of stipe to first large pinna 19–24 cm. *Reduced pinnae* to 5 pairs, 2–3 mm long, 3 cm apart. *Lamina* 27 cm long consisting of a deeply lobed apical section 18 cm long, 2.7 cm wide at base, with gradual transition to pinnae, and 5 pairs free pinnae, lowest longest, all widest near their apices; aerophores elongate. *Rachis* bearing hairs 1 mm long both sides, less abundant on lower surface with many shorter hairs. *Largest pinnae* 4–4.5 cm long, 1.6 cm wide at 1/3 from apex; base truncate; apex very abruptly short-pointed; edges lobed 1/3 to costa; costules to 3 mm apart at more than 60°; veins 7–8 pairs, 1 pair anastomosing and 2–2½ pairs passing to long sinus-membrane which is prominent on the lower surface; hairs on *lower surface* of costae pale, spreading, 0.4–0.7 mm long, on costules similar, erect veins present on surface between veins; hairs on *upper surface* of costae more than 0.5 mm long, similar hairs scattered on costules and veins, whole surface covered with fine pale appressed hairs. *Sori* medial, exindusiate; sporangia bearing several setae; spores with many small wings.

*Distr.* *Malesia*: West Java (Mt Gedeh), N. Celebes, Moluccas (Tidore, Halmahera).

*Notes.* BLUME (1829) stated that the name was given by REINWARDT to the specimen collected by REINWARDT in Tidore, which may have been the model for BLUME's plate; BLUME stated that he had also specimens from G. Gedeh (n. 908, 337–391) and these are certainly like REINWARDT's.

This species was construed in a very broad sense by CHRIST to include specimens which are here referred to several other species, and in part

he was copied by v.A.v.R. The veins on some of the lower lobes of the apical lamina are sometimes forked as in *Haplodictyum heterophyllum* PRESL. for which reason CHING transferred this species to *Haplodictyum*.

**130. *Sphaerostephanos suboppositus* HOLTUM, sp. nov.** — *Aspidium procurrens* sensu CHRIST, Ann. Jard. Bot. Btzig 15 (1898) 130, *quoad* SARASIN 128. — *Aspidium heterocarpus* sensu CHRIST, l.c. 133, *quoad* SARASIN 1326.

*Pinnæ redactae* 9-jugatae, superiores 5 mm longae; *pinnæ normales* usque 11 cm longae, ad basin auriculatam 2.5 cm latae, suboppositae, 3/5–2/3 costam versus lobatae, infimae basi leviter angustatae; costae costulaeque subtus pilis antrorsis non appressis vestitae, eglandulosae; pagina superior pilis appressis vestita; sporangia setifera. — Type: ALSTON 15744, Celebes, Minahassa, G. Lokon (BM).

*Caudex* short, suberect. *Stipe* 8 cm long, glabrescent; scales thin, 5 × 1.5 mm; base of stipe to first large pinna 30–45 cm. *Reduced pinnæ* 9 pairs, subopposite, lowest very small, uppermost 5 mm long. *Lamina* 50–70 cm long; *pinnæ* 18–21 pairs, subopposite in basal half of frond, basal 2–3 pairs somewhat narrowed at base; aerophores slender, to 1 mm long. Hairs on lower surface of *rachis* dense, short, pale; on upper surface pale, less than 0.5 mm long. *Middle pinnæ* to 11 cm long, to 2.5 cm wide at auricled base (which is sometimes a little dilated also on basiscopic side), 2.1 cm wide above base; apex acuminate; edges lobed 3/5–2/3 to costa, lobes slightly falcate with obtuse tips; costules 4.5 mm apart, at more than 60°; veins slender, 9–11 pairs, basal pair anastomosing, next acroscopic vein or pair to sinus-membrane; lower surface of costae with dense somewhat antrorse short hairs, on sterile fronds scattered long ones also present, hairs on costules and veins short, antrorse, not appressed, short erect hairs on surface between veins; upper surface of costae covered with pale hairs more than 0.5 mm long, similar hairs scattered on costules and veins, surface generally covered with pale appressed hairs. *Sori* medial, lower ones a little divergent; indusia small, thin, with a few hairs; sporangia bearing copious short setae; spores short-spinulose.

Distr. *Malesia*: N. Celebes at 1100–1400 m.

**131. *Sphaerostephanos makassaricus* HOLTUM, sp. nov.**

*Pinnæ redactae* c. 10-jugatae, usque 2 mm longae; *pinnæ normales* usque 17 × 2.8 cm, profunde lobatae; aerophori elongati; venae 12-jugatae, infimae tantum anastomosantes; costae costulaeque subtus pilis 1 mm longis brevioribus intermixtis vestitae, eglandulosae; indusia parva, tenuia, brevi-pilosa; sporangia setifera. — Type: POSTHUMUS 2727, S.W. Celebes, G. Bonthain,

S.W. slope, 1500 m, above Karoenglowe (BO).

*Caudex* short, prostrate; *stipe* 8 cm long; base of stipe to first normal pinna 50 cm or more; *reduced pinnæ* c. 10 pairs, uppermost 2 mm long, lower ones very small. *Lamina* excluding reduced *pinnæ* more than 50 cm long; 3 pairs lower *pinnæ* somewhat narrowed at their bases which are not auricled; upper *pinnæ* with almost symmetric bases. Lower surface of *rachis* bearing copious erect hairs 0.2 mm long and scattered pale hairs 1 mm long; upper surface with slender pale hairs 0.7 mm long. *Largest pinnæ* 17 × 2.8 cm, almost sessile; aerophores more than 1 mm long; base broadly cuneate; apex gradually attenuate with cauda to 2 cm long; edges lobed to 3 mm from costa, lobes falcate and somewhat tapered to a blunt apex; costules 4.5–5.5 mm apart, at 60° to costa; veins to 12 pairs, 1 pair anastomosing, next pair both ending at margin; lower surface of costae bearing copious erect hairs 0.2–0.4 mm long with many to 1 mm or more, on both sterile and fertile *pinnæ*, hairs on costules similar but fewer, few hairs on veins, no hairs and no glands between veins; upper surface of costae with pale hairs 1 mm long, shorter hairs scattered on costules and veins, appressed hairs 0.3–0.4 mm long on surface between veins. *Sori* medial, lower ones not divergent; indusia small, thin, with many short hairs; sporangia bearing 3–4 slender setae.

Distr. *Malesia*: S.W. Celebes; a second specimen is POSTHUMUS 3476, from Patapang.

**132. *Sphaerostephanos sarasinorum* HOLTUM, sp. nov.** — *Aspidium longipes* sensu CHRIST, Ann. Jard. Bot. Btzig 15 (1898) 133.

*Caudex erectus*; *stipes* 7 cm longus; *pinnæ redactae* c. 9-jugatae, omnes parvae; *lamina* 100 cm longa; *pinnæ inferiores plurimae basin versus valde angustatae*; *pinnæ omnes profunde lobatae, apicem versus abrupte caudatae*; *rachis costaeque subtus pilis brevibus vestitae*; *pagina inter venas utrinque glabra*; *sporangia setifera*. — Type: JERMY 7458, Central Celebes, Masimbolong River, 1700 m (BM).

*Caudex* short, erect, *Stipe* 7 cm long; basal scales 10 × 1.5 cm, acuminate; base of stipe to first large pinna 50 cm or more. *Reduced pinnæ* c. 9 pairs, all very small with swollen aerophores. *Rachis* short-hairy on both surfaces. *Lamina* to 100 cm long; *pinnæ* in basal half of frond all much narrowed towards their bases which in lower ones are c. 5 mm wide; upper *pinnæ* with basal lobes only reduced. *Largest pinnæ* of type 16 × 3 cm (of SARASIN 996 21 × 3.5 cm); apex abruptly narrowed to a subtertiary cauda 3 cm long; edges lobed fully 3/4 towards costa, lobes falcate; costules 4.5–6.5 mm apart; veins 12–16 pairs, basal ones anastomosing with a short excurrent vein to sinus, next acroscopic vein sometimes to sinus-membrane; hairs on lower surface of costae short,

distal ones and those on costules appressed, surface between veins glabrous, eglandular; hairs on upper surface of costae 1 mm long, similar hairs scattered on costules and veins, surface between veins glabrous or sometimes a few hairs present near tips of pinna-lobes. *Sori* medial, lower ones slightly divergent; indusia sparsely short-hairy; sporangia setiferous.

Distr. *Malesia*: Central Celebes; additional specimens are SARASIN 993, 996.

Ecol. In partial shade on very steep hillside.

Note. The SARASIN specimens lack base of fronds, for which reason JERMY's more perfect specimen is chosen as type. Very young fronds are covered with mucilage (JERMY).

**133. *Sphaerostephanos muluensis* HOLTUM, sp. nov.**

*Pinnae redactae* 8-jugatae, omnes parvae; *aerophori* leviter elongati; *pinnae normales* usque  $15 \times 2.5$  cm, *profunde lobatae*; *venae* 11–12-jugatae, *infimae non anastomosantes*; *pagina inferior pinnarum eglandulosa*; *costulae et pagina inter venas subtus pilis adpressis vestita*; *sori supramediales*; *indusia pilosa*; *sporangia interdum setifera*. — Type: B. S. PARRIS 6729, Sarawak, Gunong Mulu, 1680 m (CGE).

*Caudex* short-creeping; *stipe* 15 cm long, basal scales 10 mm long, narrow; base of *stipe* to first large pinna 50 cm; *reduced pinnae* 8 pairs, all very small. *Lamina* 70 cm long; *pinnae* 22 pairs, middle ones 3–4 cm apart, basal pair much narrowed towards their bases (several successive ones gradually less narrowed); *aerophores* (when dried) less than 1 mm long. Lower surface of *rachis* rather densely covered with erect stiff brown hairs 0.3–0.4 mm long; upper surface bearing similar but longer hairs, longest distally. *Largest pinnae*  $15 \times 2.5$  cm, sometimes with a stalk to 1 mm long; apex rather abruptly acuminate with subentire cauda 1.5–2 cm long; edges lobed to 1.5–2 mm from costa; lobes almost at right angles to costa, slightly narrowed distally, their tips obtuse; costules 5 mm apart; veins 11–12 pairs, slender, slightly prominent both sides, basal ones usually both touching sides of the sinus-membrane, less often both ending just above base of sinus; lower surface of costae covered with antrorse but not closely appressed pale hairs 0.6 mm long, hairs on costules a little shorter, closely appressed, slender appressed hairs 0.2–0.3 mm long on surface between veins; upper surface bearing hairs about the same length as on lower surface but thicker, no long hairs on costules and veins, surface between veins bearing appressed hairs 0.3 mm long. *Sori* distinctly supramedial; indusia rather thin, covered with hairs 0.3 mm long; some sporangia bearing a short seta.

Distr. *Malesia*: Borneo (Sarawak), 3 collections.

Ecol. In forest at 1680–1800 m.

**134. *Sphaerostephanos telefominicus* HOLTUM, sp. nov.**

*S. roemeriano* (Rosenst.) Holttum *affinis*, *ab ea differt*: *caudice tenue, erecto vel scandente*; *lamina longiore*, *pinnis 20-jugatis constata*; *pinnis distaliter solum crenatis*; *pagina supra et subtus pilis adpressis vestita*. — Type: W. R. BARKER & J. R. CROFT LAE 67649, N.E. New Guinea, W. Sepik Distr., Telefomin Subdistr. (K; LAE).

*Caudex* slender, erect, sometimes creeping up small shrubs (collectors); *stipe* 5–12 cm long, copiously scaly, scales 5 mm long, less than 1 mm wide, firm, hairy. *Lamina* to 25 cm long; *pinnae* more than 20 pairs, isomorphous; basal 2–3 pairs slightly and gradually reduced, smallest 1.2 cm long, subsessile, base unequally cuneate, not auricled; apical lamina not pinna-like. *Largest pinnae*  $3.0 \times 0.8$  cm, with stalk 0.5 mm long; base broadly cuneate to subtruncate, sometimes slightly dilated both sides; apex short-acuminate; edges subentire or slightly crenate distally; costules 2 mm apart or a little more; veins to 4 pairs, 2 pairs anastomosing, next acroscopic vein passing to short sinus-membrane; lower surface of rachis and costae bearing copious erect hairs 0.2 mm long (on sterile pinnae 0.3 mm), costules and veins sparsely hairy, surface between veins of sterile pinnae bearing many slender appressed hairs; upper surface of rachis bearing hairs 0.5 mm long with scattered ones 1 mm, shorter hairs present on costae and a few on costules and veins, between veins slender appressed hairs 0.3 mm long. *Sori* medial; indusia thin, fairly large, with short hairs; sporangia of type immature, not setiferous, no glands seen on them.

Distr. *Malesia*: Papua New Guinea (Telefomin), only known from the type.

Ecol. In disturbed montane forest near river, at 1500 m.

**135. *Sphaerostephanos roemerianus* (ROSENST.) HOLTUM, comb. nov. — *Dryopteris roemeriana* ROSENST. Nova Guinea 8 (1912) 723; v.A.v.R. Handb. Suppl. (1917) 179. — *Thelypteris roemeriana* (ROSENST.) REED, Phytologia 17 (1968) 310. — Type: VON ROEMER 1023, W. New Guinea, 1350 m (BO).**

*Caudex* short, erect. *Stipe* 3 cm long, covered with short pale hairs; scales narrow. *Lamina* to 12 cm long; apex pinna-like; *pinnae* 10–12 pairs, lower 2–3 pairs gradually smaller, lowest 3–7 mm long. Lower surface of *rachis* covered with pale spreading hairs 0.3 mm long. *Largest pinnae* to  $3.0 \times 0.8$  cm; base unequally cuneate, sometimes a little auricled on acroscopic side; apex slightly tapered to a rounded tip; edges crenate; costules 2.5 mm apart, at  $45^\circ$ ; veins to 3 pairs, basal pair anastomosing; lower surface of costae, costules and veins bearing rather sparse short hairs; hairs present on upper surface of costae, scattered on costules and veins. *Sori* inframedial; indusia large,

glabrous; sporangia not setose, no glands seen.

Distr. *Malesia*: W. New Guinea, only known from the type.

**136. *Sphaerostephanos hellwigensis* HOLTUM, sp. nov.**

*Caudex erectus, usque 30 cm altus; pinnae redactae 4-5-jugatae, usque 8-9 mm longae; pinnae normales usque 4.5 × 0.9 cm, crenatae, eglandulosae, costae costulaeque subtus pilis erectis brunneis 0.5-0.6 mm longis vestitae; sori mediales, indusia parva, pilis brevibus praedita; sporangia non setifera, ut videtur non glandulosa.* — Type: PULLE 884, W. New Guinea, Mt Hellwig, 2600 m (BO).

*Caudex* erect, to 30 cm tall (collector); stipe 5-10 cm long, scales rather firm, 5 × 1 mm; base of stipe to first normal pinna 20 cm; *reduced pinnae* 4-5 pairs, lowest 1-2 mm long, uppermost 8-9 mm long with an acroscopic auricle 4 mm long, basis-copic base narrower, edges almost entire. *Lamina* excluding reduced pinnae 40 cm long; pinnae to c. 30 pairs, texture rigid; basal normal pinnae not narrowed at their bases. *Largest pinnae* 4.5 × 0.9 cm; base truncate and slightly dilated; aerophores c. 0.5 mm long; apex short-acute; edges crenate to a depth of 1 mm or a little more deeply; costules 2.5 mm apart; veins to 4 pairs, prominent both sides, 1 pair anastomosing, next acroscopic vein or pair to the sinus-membrane; *lower surface* of rachis bearing thick erect brown hairs 1 mm long, of costae similar hairs 0.5-0.6 mm long, fewer on costules, no hairs between veins, no glands; *upper surface* of rachis covered with antrorse brown hairs, brownish antrorse hairs less than 0.5 mm long on costae, a few short hairs on costules distally. *Sori* medial; indusia small, thin, with a few short hairs; sporangia not setiferous, no glands seen on them.

Distr. *Malesia*: W. New Guinea (Mt Hellwig), 2600 m.

**137. *Sphaerostephanos benoitianus* (GAUD.) HOLTUM, comb. nov.** — *Polystichum benoitianum* GAUD. in Freyc. Voy. Uran. Phys. Bot. (1827) 331. — *Aspidium benoitianum* GAUD. *ibid.* t. 11. — *Dryopteris benoitiana* (GAUD.) V.A.V.R. Handb. (1908) 225. — Type: GAUDICHAUD, New Guinea, Rawak Island (G; BM, FI-W).

*Caudex* short, creeping. *Stipe* 7-9 cm long, short-hairy; basal scales dark, firm, 4 mm long. *Lamina* 27 cm long; apical 10-12 cm narrowly triangular and deeply lobed, grading to upper pinnae; free pinnae 10-12 pairs; basal 1-2 pairs somewhat reduced, narrowed at base on basis-copic side, not on acroscopic, in middle wider on basis-copic than on acroscopic side of costa. *Lower surface* of rachis bearing short erect hairs and scattered pale ones 1 mm long, hairs on its upper surface thick, brown, spreading. *Largest pinnae* 5.5 × 1.4 cm; base subtruncate, symmetric;

apex short-acuminate; edges lobed a little more than  $\frac{1}{2}$  way to costa (to  $\frac{2}{3}$  on fertile fronds), lobes slightly falcate; costules 3 mm apart; veins 6-8 pairs, basal pair anastomosing, next acroscopic vein to sinus-membrane or to margin; *lower surface* of costae and costules hairy as rachis; hairs on *upper surface* of costae sparse, short and long, rest of surface usually glabrous. *Sori* submarginal; indusium small, bearing short hairs; sporangia with neither glands nor setae; spores dark, minutely papillose.

Distr. *Malesia*: W. New Guinea (Rawak I.), only known from the type.

Note. This appears to be an isolated species, possibly related to *S. invisus*.

**138. *Sphaerostephanos neotoppingii* HOLTUM, nom. nov.** — *Dryopteris toppingii* COPEL. Philip. J. Sci. 12 (1917) Bot. 56; C. CHR. Gard. Bull. Str. Settl. 7 (1934) 246. — *Thelypteris toppingii* (COPEL.) K. IWATS. Acta Phytotax. Geobot. 21 (1965) 168, not *Sphaerostephanos toppingii* (COPEL.) C. CHR. 1934. — Type: TOPPING 1766, Sabah, Mt Kinabalu, Lobang (AFS, not seen).

*Caudex* short, creeping. *Stipe* 50-90 cm long, dull reddish, minutely hairy; scales narrow, to 10 mm long. *Reduced pinnae* lacking. *Lamina* 50-80 cm long; pinnae 10-15 pairs, lowest not or little reduced; several pairs lower pinnae much narrowed towards their bases and stalked 3-4 mm, distal ones broadly cuneate to subtruncate, almost sessile; aerophores not elongate. *Rachis* densely short-hairy (0.2-0.3 mm) on both surfaces. *Largest pinnae* commonly 15-20 × 2.0-2.5 cm (maximum 24 × 3.5 cm); base cuneate; apex acuminate with subentire cauda 1.5-2.5 cm; edges lobed 1/3-2/5 to costa, lobes distinctly falcate with narrow blunt forward-pointing tips; costules 5-6.5 mm apart at more than 60°; veins to 12 pairs on acroscopic side of costule, to 14 on basis-copic side, prominent on lower surface,  $1\frac{1}{2}$ -2 $\frac{1}{2}$  pairs anastomosing, 1-2 pairs to sides of sinus-membrane; hairs on *lower surface* of costae antrorse but not closely appressed, 0.2-0.3 mm long with some 0.5 mm, similar and more sparse hairs on costules and veins, on surface between veins a variable number of short suberect hairs, glands lacking; hairs on *upper surface* of costae 0.3 mm long, shorter on costules, between veins (especially on young fronds) some short appressed hairs. *Sori* supramedial, those on lowest veins from adjacent costules sometimes touching; indusia firm, glabrous, sometimes a little elongate and asymmetric at base; sporangia lacking glands and setae, hair on sporangia-stalk ending in a red gland.

Distr. *Malesia*: Borneo (Sabah and Kalimantan), in forest at 1200-1500 m.

**139. *Sphaerostephanos oosorus* (BAK.) HOLTUM, comb. nov.** — *Nephrodium oosorum* BAK. Kew Bull. (1896) 41. — *Dryopteris oosora* (BAK.) C.



CHR. Ind. Fil. (1905) 280; Gard. Bull. Str. Settl. 7 (1934) 245. — Type: G. F. HOSE 334, Sabah, Pulo Gaya (K).

*Caudex* short, creeping. *Stipe* 25–40 cm long, minutely hairy; base of stipe to first large pinna 40–55 cm. *Reduced pinnae* 2–4(–6) pairs, uppermost 4 mm long. *Lamina* 60 cm long; pinnae to 20 pairs, sessile; 2–3 pairs lower pinnae narrowed at their bases; aerophores not elongate. Lower surface of *rachis* covered with short erect pale hairs 0.2–0.4 mm long, in some specimens mixed with long ones to 1 mm; upper surface with uniform pale hairs 0.5 mm long. *Largest pinnae* commonly 12–15 × 1.8–2.0 cm (largest seen 21 × 2.4 cm); apex acuminate with cauda to 1.5 cm; edges lobed a little less than  $\frac{1}{2}$  way to costa, lobes oblique, narrowed to obtuse tips; costules 4–4.5 mm apart, at 60°; veins to 8 pairs, basal  $1\frac{1}{2}$  pairs anastomosing, 1– $1\frac{1}{2}$  pairs to sinus-membrane; lower surface of costae covered with erect hairs varying from 0.2 to 0.5 mm, hairs on costules and veins similar but shorter, surface between veins bearing many short erect hairs; hairs on upper surface of costae 0.5 mm long, shorter on costules, abundant short suberect hairs between veins. *Sori* medial, elongate, 1.5 mm long; indusia large, pale, firm, bearing many short hairs and rarely a gland; neither glands nor setae on sporangia; spores minutely papillose.

Distr. *Malesia*: Borneo (Sabah & P. Balam-bangan).

Ecol. In forest at low altitudes.

**140. *Sphaerostephanos rudis* (RIDL.) HOLTUM, comb. nov.** — *Goniopteris rudis* RIDL. Trans. Linn. Soc. Bot. 9 (1916) 259. — *Phegopteris ridleyana* v. A.V.R. Handb. Suppl. (1917) 515, nom. nov. — *Dryopteris rufopilosa* BRAUSE, Bot. Jahrb. 56 (1920) 106, nom. nov. (not *D. rudis* (KUNZE) C. CHR. nor *D. ridleyana* BRAUSE). — Type: KLOSS s.n. W. New Guinea, Mt Carstensz, Camp I–III, 150–750 m (BM; K).

#### KEY TO THE VARIETIES

1. Lower surface of rachis and costae bearing thick reddish hairs . . . . . **a. var. rudis**

1. Lower surface of rachis and costae glabrous . . . . . **b. var. micans**

#### **a. var. rudis**

*Caudex* short-creeping; *stipe* 10 cm long, dark reddish, dark-hairy in groove, scales 7 × 1 mm, thin; base of stipe to first normal pinna 35 cm; *reduced pinnae* 5–6 pairs, all very small, with short aerophores. *Lamina* 50 cm long; apex pinna-like; pinnae 4 pairs, opposite, all widest at or above middle and gradually narrowed to an abruptly cuneate base. Lower surface of *rachis* covered with thick spreading dark red hairs 1 mm long. *Largest pinnae* 20 × 4.5 cm; apex abruptly acuminate with cauda 2–2.5 cm long; edges entire;

costules 5 mm apart; veins 8 pairs, most of them united to form a zig-zag excurrent vein; lower surface of costae bearing thick erect reddish hairs 0.5 mm long which are more sparse distally, hairs on costules short and sparse, none on surface between veins; upper surface glabrous apart from a few hairs in groove of costa. *Sori* medial, exindusiate; sporangia bearing neither glands nor setae.

Distr. *Malesia*: W. New Guinea and Japen Island, at low altitudes.

**b. var. micans** (BRAUSE) HOLTUM, stat. nov. — *Dryopteris micans* BRAUSE, Bot. Jahrb. 56 (1920) 98. — *Cyclosorus micans* (BRAUSE) COPEL. Gen. Fil. (1947) 143; Philip. J. Sci. 78 (1951) 458. — *Thelypteris micans* (BRAUSE) REED, Phytologia 17 (1968) 293. — Type: LEDERMANN 12468, N.E. New Guinea, Sepik Distr. 1400–1500 m (B).

Differs from *var. rudis* in quite glabrous lower surface of rachis and costae; all specimens also are larger, with up to 10 pairs of reduced pinnae and 6 pairs of normal ones which are not opposite, largest 27 × 5.5 cm.

Distr. *Malesia*: New Guinea, from Idenburg River eastwards, at 850–1750.

**141. *Sphaerostephanos dimorphus* (BRAUSE) HOLTUM, comb. nov.** — *Dryopteris dimorpha* BRAUSE, Bot. Jahrb. 56 (1920) 100. — *Cyclosorus dimorphus* (BRAUSE) COPEL. Philip. J. Sci. 78 (1951) 442. — *Thelypteris dimorpha* (BRAUSE) REED, Phytologia 17 (1968) 273. — Type: LEDERMANN 12622, N.E. New Guinea, Sepik Distr., 1400–1500 m (B).

*Dryopteris morobensis* COPEL. Univ. Cal. Publ. Bot. 18 (1942) 221. — *Cyclosorus morobensis* (COPEL.) COPEL. Gen. Fil. (1947) 143; Philip. J. Sci. 78 (1951) 459, pl. 38. — *Thelypteris morobensis* (COPEL.) REED, Phytologia 17 (1968) 294. — Type: CLEMENS s.n. N.E. New Guinea, Morobe Distr., Finugan, 1400 m (MICH).

*Caudex* erect, 100–150 cm tall. *Stipe* 10–20 cm long, dull red, glabrous, with many scales to 15 × 2 mm. *Lamina* to 140 cm long; apex pinna-like; pinnae to 40 pairs, dimorphous, lower 10–12 pairs gradually reduced, lower ones narrowly triangular with ± hastate base, lowest 7–15 mm long; aerophores swollen, not or little elongate. *Rachis* glabrous apart from dark red hairs in groove of upper surface, most abundant distally. *Largest sterile pinnae* commonly 20 × 2.0 cm (on type to 36 × 1.8 cm); base asymmetric, rounded on basis-copic side, cuneate on acroscopic; apex narrowly acuminate; edges slightly undulate; costules 4–5 mm apart, at a wide angle to costa; veins 4–6 pairs, all very oblique, pale and prominent on lower surface, 2–2 $\frac{1}{2}$  pairs anastomosing and 1 pair to sides of sinus-membrane; both surfaces of pinnae quite glabrous. *Fertile pinnae* 7–14 cm long,

0.7–1.2 cm wide; edges entire as sterile, or crenate (rather strongly crenate in type of *D. morobensis*); veins 4 pairs; sori confluent at maturity; indusia glabrous or with a few short hairs; sporangia lacking glands and setae; spores minutely papillose.

Distr. *Malesia*: Eastern New Guinea, in forest at 1200–2000 m, many collections.

**142. *Sphaerostephanos potamios* HOLTUM, sp. nov.**

*Caudex erectus, c. 20 cm altus; frondes dimorphae, omnes pinnis redactis 6-8-jugatis praeditae; pinnae steriles 15 × 1.6 cm, fertiles usque 8.0 × 0.8 cm, non ultra 1/4 costam versus lobatae, subtus eglandulosae; rachis pilis brunneis vestita; sori mediales; indusia parva, glabra vel pauci-pilosa; sporangia nec setis nec glandulis praedita.* — Type: J. CROFT & Y. LELEAN NGF 34913, S.E. New Guinea, Port Moresby Subdistr. near Lake Myola (L).

*Caudex* erect, 20 cm tall; *stipe* 8 cm long, basal scales 7–8 × 1 mm, covered with many short hairs; base of *stipe* to first large pinna of sterile frond 25 cm, of fertile 35–42 cm; *reduced pinnae* of fertile frond 6–8 pairs, not opposite, uppermost 1.5 cm long with basal acroscopic auricle 8 mm long, apex acute, lowest reduced pinna 3–4 mm long. *Lamina* 63 cm long (sterile); *pinnae* 30 pairs, basal *pinnae* with slightly dilated truncate bases; texture firm; apex of frond not pinna-like; *aerophores* slightly swollen. *Sterile pinnae* to 15 × 1.6 cm; apex narrowly acuminate; edges lobed to a depth of 1–2.5 mm, lobes with falcate tips and slight projections at ends of veins; costules 3.5–4.5 mm apart; veins 6–7 on basisopic side, 5–6 on acroscopic, pale and prominent on lower surface, reddish on upper, basal 1–1½ pairs anastomosing, 1½ pairs passing to the rather long sinus-membrane; *lower surface* of rachis bearing rather sparse thick brown hairs 0.7 mm long, hairs on costae sparse, pale, erect, 0.3–0.4 mm long, hairs on costules shorter, ± antrorse, not appressed, surface between veins hairless, slightly pustular; *upper surface* of rachis with brown hairs to 1 mm long, of costae with pale hairs 0.5–0.7 mm, no other hairs. *Fertile pinnae* to 8.0 × 0.8 cm (apparently not quite fully expanded); veins 3–4 pairs; hairs on both surfaces shorter and more sparse than on sterile *pinnae*; sori medial; indusia small, thin, glabrous or with a few short hairs; sporangia not setiferous, no glands seen on them.

Distr. *Malesia*: S.E. New Guinea; only known from the type.

Ecol. In forest close to stream-bank, at 1900 m.

**143. *Sphaerostephanos invisus* (FORST. f.) HOLTUM, Webbia 30 (1976) 195; Allertonia 1 (1977) 211, f. 7B. — *Polypodium invisum* FORST. f. Fl. Ins. Austr. Prodr. (1786) 81. — *Nephrodium invisum* (FORST. f.) CARR. in Seem. Fl. Vit. (1873)**

362. — *Dryopteris invisus* (FORST. f.) O. KTZE, Rev. Gen. Pl. 2 (1891) 813; v.A.v.R. Handb. (1908) 212; COPEL. Bishop Mus. Bull. 59 (1929) 45; 93 (1932) 38. — *Cyclosorus invisus* (FORST. f.) COPEL. Gen. Fil. (1947) 142; BROWNLIE in Aubrév. Fl. Nouv. Cal. 3 (1969) 215, excl. syn. *Nephrodium haenkeanum* PRESL. — *Thelypteris forsteri* MORTON, Contr. U.S. Nat. Herb. 38 (1967) 60, nom. nov. (not *T. invisus* (DESV.) PROCTOR). — Type: FORSTER, locality unrecorded (BM; K, LE).

*Aspidium dissectum sensu* METT. Ann. Mus. Bot. Lugd.-Bat. 1 (1864) 232, excl. synonym.

*Caudex* a long-creeping rhizome to 7 mm diameter. *Stipe* 25–45 cm or more long. *Lamina* commonly 40–75 cm long (to 120 cm); basal 2 pairs of *pinnae* gradually smaller and irregularly spaced, lowest sometimes 2 cm long, usually longer; *aerophores* not elongate. *Largest pinnae* commonly 15 × 1.3 cm (to 24 × 1.8 cm), narrowly acuminate, lobed 1/3–2/5 to costa, lobes falcate, distinctly pointed, oblique; costules commonly 3–3.5 mm apart; veins 7–8 pairs, close, very oblique except basal pair, 1–1½ pairs anastomosing, 1–2 pairs to sinus-membrane; short spreading hairs on all part of *lower surface*, a little antrorse on costules, erect (sometimes lacking) between veins; *upper surface* almost glabrous apart from costae. *Sori* supramedial; indusia thin, hairy; sporangia bearing a variable number of setae; spores dark, with irregular ± continuous brownish wing and a few cross-wings.

Distr. Polynesia (many islands in the Pacific eastward to Tahiti and Hawaii), New Caledonia, Queensland; in *Malesia*: New Guinea (lowlands of north and east) and Moluccas (Kei & Tenimber Is., Amboina).

Ecol. In open or lightly shaded places, sometimes in wet ground, at low altitudes.

**144. *Sphaerostephanos austerus* (BRAUSE) HOLTUM, comb. nov. — *Dryopteris austera* BRAUSE, Bot. Jahrb. 56 (1920) 108. — *Cyclosorus austerus* (BRAUSE) COPEL. Philip. J. Sci. 78 (1951) 446. — *Thelypteris austera* (BRAUSE) REED, Phytologia 17 (1968) 262. — Type: LEDERMANN 11750, N.E. New Guinea, Sepik Distr., 2070 m (B).**

*Caudex* slender, scandent. *Stipe* 11–18 cm long. *Lamina* 65–100 cm long; 5–6 pairs lower *pinnae* gradually reduced, all with an acroscopic auricle, lowest 1.3 cm long, subtriangular with rounded apex; *aerophores* not elongate. Hairs on lower surface of rachis dense, short; on upper surface a little longer. *Largest pinnae* 9–13 cm long, 2.2–3.0 cm wide; base subtruncate; apex abruptly short-acuminate; edges lobed ½ way to costa or a little more deeply, lobes falcate, blunt-pointed; costules 5–5.5 mm apart, at 60°; veins 7 pairs, slender, basal pair anastomosing, next pair usually both to margin; *lower surface* of costae bearing dense short pale somewhat antrorse hairs of uni-

form length, similar hairs sparse on costules, scattered on surface between veins; hairs on upper surface of costae short, scattered longer ones present on costules and veins, surface between veins bearing scattered short appressed hairs. *Sori* slightly inframedial, exindusiate; sporangia with a few setae; spores minutely spinulose.

Distr. *Malesia*: Papua New Guinea (Sepik), only known from type.

**145. *Sphaerostephanos mundus* (ROSENST.) HOLTUM, comb. nov.** — *Dryopteris munda* ROSENST. Meded. Rijksherb. n. 31 (1917) 5. — *Thelypteris munda* (ROSENST.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 252. — Type: ATASRIP s.n. 1903, W. New Guinea (L).

*Dryopteris oblonga* BRAUSE, Bot. Jahrb. 56 (1920) 109. — *Cyclosorus oblongus* (BRAUSE) COPEL. Philip. J. Sci. 78 (1951) 446. — *Thelypteris oblonga* (BRAUSE) REED, Phytologia 17 (1968) 297. — Type: LEDERMANN 10100, N.E. New Guinea, Sepik Distr., 1000 m (B).

*Dryopteris farinosa* BRAUSE, Bot. Jahrb. 56 (1920) 111. — *Cyclosorus farinosus* (BRAUSE) COPEL. Philip. J. Sci. 78 (1951) 446. — *Thelypteris farinosa* (BRAUSE) REED, Phytologia 17 (1968) 276. — Type: LEDERMANN 12103, Sepik Distr., 2070 m (B).

*Caudex* a scandent rhizome 7–10 mm diameter, or sometimes free, slender, erect. *Stipe* 5–10 cm long, dark; base of stipe to first large pinna 25–35 cm. *Reduced pinnae* 5–7 pairs, smallest 3–4 mm long, uppermost 10 mm, spreading, triangular with base auricled both sides (more on acroscopic side). *Lamina* 60–100 cm long; pinnae c. 25 pairs, not dimorphic; lower pinnae a little narrowed to symmetric base; aerophores not elongate. Lower surface of *rachis* sparsely short-hairy; upper surface with hairs to 1 mm long. *Largest pinnae* commonly 9–12 cm long, 2.0–2.5 cm wide (on type of *D. oblonga* 18 × 2.6 cm); base broadly cuneate; apex rather abruptly acuminate with cauda 1.5–3 cm long; edges lobed 2/3–3/4 to costa, lobes falcate with blunt forward-pointing tips; costules 4–5 mm apart (to 6.5 mm on type of *D. oblonga*); veins 7–9 pairs, basal pair anastomosing to form a short excurrent vein to sinus, next pair both to margin; lower surface of costae bearing rather sparse short erect hairs (dense with some longer ones on type of *D. oblonga*), sparse short hairs on costules, veins and surface between veins; hairs on upper surface of costae less than 1 mm long, sparse short hairs on costules and veins, a variable number of fine appressed hairs between veins (in some cases very sparse). *Sori* inframedial, lowest not or little divergent; indusia absent or very small with a few hairs; sporangia setiferous; spores closely papillose.

Distr. *Malesia*: New Guinea, from West to East. Ecol. Usually climbing on trees in forest, at 1000–2000 m.

Note. BRAUSE distinguished *D. farinosa* by a grey-yellow deposit on the lower surface; this consists of a fungus. In the type of *D. munda* and others from Western New Guinea, basal veins sometimes meet at the sinus without anastomosing.

**146. *Sphaerostephanos obtusifolius* (ROSENST.) HOLTUM, comb. nov.** — *Dryopteris obtusifolia* ROSENST. Fedde Repert. 10 (1912) 336. — *Phegopteris obtusifolia* (ROSENST.) v.A.v.R. Handb. Suppl. (1917) 315. — *Cyclosorus obtusifolius* (ROSENST.) COPEL. Gen. Fil. (1947) 143; Philip. J. Sci. 78 (1951) 442. — *Thelypteris obtusifolia* (ROSENST.) REED, Phytologia 17 (1968) 297. — Type: Frau BAMLER 43, N.E. New Guinea, Sattelberg (not seen).

*Caudex* short, creeping. *Stipe* 2–8 cm long. *Lamina* 8 cm long; apex not pinna-like; pinnae c. 8 pairs, 1 or 2 basal pairs reduced, lowest 4–6 × 3–5 mm; aerophores slightly swollen. Hairs on lower surface of *rachis* minute, on upper surface 0.4 mm long, brown. *Largest pinnae* 1.5–2.0 cm long, 0.8–1.0 cm wide; base subtruncate, slightly asymmetric; apex broadly rounded, edges sinuose with very slight development of sinus-membranes; costules 2.5 mm apart; veins 2–3 pairs, 1½ pairs anastomosing; all hairs on lower surface minute; on upper surface short hairs on costae only or a few between veins near margin. *Sori* exindusiate, those on basal veins from adjacent costules sometimes fusing; sporangia setiferous; spores pale, with a moderate number of wings of varying extent.

Distr. *Malesia*: New Guinea (Sattelberg, several collections; Manus Island).

Notes. At BM is a specimen labelled KEYSER 43, from the type locality, named *D. obtusifolia* by ROSENSTOCK; this is probably an error for BAMLER 43 (ROSENSTOCK was describing specimens from both collectors). Also from Sattelberg is Rosenst. Fil. Novoguin. exsicc. 115, coll. BAMLER (B, BM, W). M. SANDS 2682 (K) from limestone on Manus Island is closely similar to the Sattelberg specimens but less hairy on both surfaces of pinnae.

**147. *Sphaerostephanos alcasidii* HOLTUM, sp. nov.**

*Pinnae redactae plurimae*, 1.5 cm inter se distantes, aerophoris tumidis tantum constitutae; lamina 80 cm longa; pinnae 35-jugatae, maximae 15 × 1.5 cm, 3/5 costam versus lobatae, eglandulosae; pagina utroque latere inter venas pilis adpressis vestita; indusia parva brevi-pilosa; sporangia setifera. — Type: ALCASID PNH 1747, Luzon, Mountain Prov., Mt Data (MICH).

*Caudex* not known. *Stipe* 10 cm long; base of stipe to first large pinna 50 cm. *Reduced pinnae* many pairs, 1.5 cm apart, all except the very small upper ones consisting of an aerophore without

perceptible blade. *Lamina* 80 cm long; pinnae 35 pairs, lowest narrowed to 8 mm wide at the base. Lower surface of *rachis* near base covered with appressed hairs 0.5 mm long, distally with longer spreading hairs; hairs on upper surface similar. *Largest pinnae* 15 × 1.5 cm; base truncate; apex acuminate with entire cauda 1–2 cm long; edges lobed a little more than  $\frac{1}{2}$  way to costa, lobes falcate; costules 3.5 mm apart at more than 60°; veins 8–9 pairs, basal pair anastomosing, next acroscopic vein to sinus-membrane; hairs on lower surface of costae near base appressed, 0.5 mm long, stally and on costules longer and spreading, appressed hairs on lower surface between veins; *upper surface* of costae bearing hairs 1 mm long, similar hairs scattered on costules and veins, copious appressed hairs 0.3 mm long on surface between veins. *Sori* medial; indusia small with short hairs; sporangia sometimes with 1–2 setae.

Distr. *Malesia*: Philippines (Luzon: Mt Data), only known from the type.

**148. *Sphaerostephanos pilosissimus* HOLTUM, sp. nov.**

*Pinnae redactae* 12-jugatae, infimae 0.7 cm longae, superiores 2.5 cm, anguste triangulares, crenatae; *pinnae evolutae* usque 16.5 × 2.3 cm, dimidio costam versus lobatae; costae costulaeque subtus pilis erectis vestitae, eglandulosae; indusia pilifera; *sporangia setifera*. — Type: HOLTUM 2022, Sumatra, G. Kerinci, 1800–2100 m (SING; BO).

*Caudex* erect, short. *Stipe* 15 cm long, glabrous; base of stipe to first large pinna 40 cm. *Reduced pinnae* at least 12 pairs, deflexed, basal one 7 mm long, uppermost 2.5 cm long, narrowly triangular with acute apex, crenate edges and slight basal acroscopic auricle. *Lamina* 65 cm long; pinnae 25 pairs; basal pinnae narrowed and less deeply lobed to base which is 1.3 cm wide, basal basicopic lobes of several successively higher pinnae shortened; aerophores swollen, not elongate. Hairs on lower surface of *rachis* dense, erect, 0.3 mm long, on upper surface more than 0.5 mm long, pale. *Largest pinnae* 16.5 × 2.3 cm; base truncate; apex acuminate with subentire cauda to 2.5 cm long; edges lobed about  $\frac{1}{2}$  way to costa, lobes slightly oblique with rounded tips; costules 4.5 mm apart; veins 10–14 pairs, basal 2 pairs anastomosing, 1 pair to sinus-membrane; *lower surface* of costae and costules densely covered with erect hairs of varied length to 0.5 mm, less dense hairs on veins and surface more than 0.5 mm long; hairs on *upper surface* of costae 0.7 mm long, costules, veins and surface between them covered with slender appressed hairs 0.3 mm long. *Sori* a little inframedial, lower ones not divergent; indusia fringed with short hairs and a few on surface; sporangia bearing 2–3 short setae.

Distr. *Malesia*: West Central Sumatra (G.

Kerinci), 2 collections (ALSTON 14185, BM), 1800–2100 m.

**149. *Sphaerostephanos erwinii* HOLTUM, sp. nov.**

*Frondes parvae, lamina apicali* 7–8 cm longa, *pinnis evolutis* 6-jugatis *pinnisque redactis* 4-jugatis constitutae; *pinnae redactae* usque 8 mm longae; *pinnae evolutae* usque 3.2 × 1.3 cm, subintegrae; indusia parva, pilosa; *sporangia setifera*. — Type: STRESEMANN 43, Ceram, Centralgeb., G. Hoale, 1000 m (L).

*Caudex* short, suberect. *Stipe* 7 cm long, slender, short-hairy; base of stipe to first large pinna 17 cm. *Reduced pinnae* 4 pairs, ovate, uppermost 8 mm, lowest 3–4 mm long. *Apical lamina* 7–8 cm long, 2.5 cm wide at base, deeply lobed and grading to pinnae; free pinnae 6 pairs. Lower surface of *rachis* bearing thick brown hairs and shorter pale ones. *Largest pinnae* 3.2 × 1.3 cm, widest a little above middle; base truncate, sometimes with a slight acroscopic auricle; apex abruptly narrowed to a rounded or obtuse tip; edges shallowly crenate; costules 3.5 mm apart, at little more than 45°; veins 3 pairs,  $1\frac{1}{2}$  pairs anastomosing; hairs on lower surface of costae short, erect, with some longer, sparse hairs on costules and veins, short erect hairs on surface between veins; scattered long hairs on upper surface of costules and veins like those on costae, appressed hairs on surface between veins. *Sori* medial; indusia small with hairs more than 0.5 mm long; sporangia setiferous.

Distr. *Malesia*: Moluccas (Ceram) and West New Guinea.

Note. The plant from W. New Guinea (KOSTERMANS 2209a, Angi-gita Lake, at 2000 m, BO) is smaller than the type, with pinnae to 2.2 × 0.8 cm, and only 2 pair of reduced basal pinnae.

**150. *Sphaerostephanos atasripii* (ROSENST.) HOLTUM, Webbia 30 (1976) 194. — *Dryopteris atasripii* ROSENST. Meded. Rijksherb. n. 31 (1917) 6; C. CHR. Brittonia 2 (1937) 298. — *Thelypteris atasripii* (ROSENST.) REED, Phytologia 17 (1968) 261. — Type: ATASRIPI 211, W. New Guinea (L).**

*Cyclosorus diminuens* HOLTUM, Blumea 13 (1965) 135. — Type: BRASS 32106, N.E. New Guinea, Eastern Highlands, Arau, 1400 m (K).

*Caudex* massive, erect. *Stipe* 13 cm long; base of stipe to first large pinna 75 cm. *Reduced pinnae* 15 pairs, spreading, broadly triangular, lowest 6–7 mm long and 10 mm wide at base, uppermost 4–5 × 2.5–3.0 cm. *Lamina* to more than 100 cm long; apex not pinna-like; lower pinnae not narrowed at base; aerophores slightly swollen. Lower surface of *rachis* densely covered with erect hairs 0.1–0.2 mm long; upper surface covered with appressed pale hairs 0.5 mm long with thicker

spreading brown hairs 1 mm long on each side of the groove. *Largest fertile pinnae*  $17 \times 2.5$  cm, *sterile* to  $22 \times 3.1$  cm; base truncate and somewhat dilated both sides; apex short-acuminate; edges lobed to a depth of 2–3 mm; costules 4–4.5 mm (fertile), to 6 mm (sterile) apart; veins 9–11 pairs, 2–3 pairs anastomosing, 2–3 pairs to sides of sinus-membrane; *lower surface* of costae densely covered with short hairs as rachis, hairs on costules and veins more sparse, on sterile pinnae longer than those on costae, copious short erect hairs on surface between veins; hairs on *upper surface* of costae 0.7 mm long, a few similar hairs on costules and veins, surface between veins  $\pm$  densely covered with fine appressed hairs. *Sori* medial, lower ones not divergent; indusia covered with hairs 0.3 mm long; sporangia setiferous, sometimes with an acicular hair on the stalk; spores closely and minutely spinulose. *Chromosomes*:  $n = 36$  (T. G. WALKER).

Distr. *Malesia*: throughout New Guinea, in forest at 700–1400 m.

Notes. This species is very similar to *S. confertus* in all characters except the massive erect caudex and much larger fronds which never bear glands. In cultivation the two remain quite distinct in size and habit.

**151. *Sphaerostephanos albosetosus* (COPEL.) HOLTUM, comb. nov.**—*Dryopteris albosetosa* COPEL. Univ. Cal. Publ. Bot. 18 (1942) 221.—*Cyclosorus albosetosus* (COPEL.) COPEL. Gen. Fil. (1947) 142; Philip. J. Sci. 78 (1951) 455, pl. 35.—*Thelypteris albosetosa* (COPEL.) REED, Phytologia 17 (1968) 259.—Type: BRASS 11435, W. New Guinea, 18 km north of Lake Habbema, on dry face of a limestone wall, in shade (MICH; BM, BO, L).

*Caudex* short, creeping, 4–5 mm diameter, bearing close but seriate stipes; *stipe* 6 cm long, basal scales ovate, 1 mm long; base of stipe to first normal pinna 12–24 cm; *reduced pinnae* 6 pairs, lowest 4 mm long, others gradually longer; transition to normal pinnae subabrupt, an intermediate pair 1.5 cm long, 6 mm wide above auricled base, apex broadly obtuse. *Lamina* 21 cm long; pinnae 10 pairs, lower ones not auricled at their bases; aerophores not elongate. Lower surface of *rachis* bearing short pale erect hairs with some to 1 mm long; hairs 1 mm long also on upper surface. *Largest pinnae*  $4.0 \times 1.0$  cm; base truncate on acroscopic side, rounded on basicopic; apex abruptly narrowed to obtuse tip; edges lobed to a depth of 1.5–2 mm, lobes strongly concave beneath (specimen at BO); costules 3.5 mm apart; veins 4–6 pairs, thick and prominent on lower surface, basal pair anastomosing, second pair passing to sinus-membrane or margin; *lower surface* of costae bearing short erect hairs mixed with longer ones to 1 mm, more sparse similar hairs on costules,

short slender erect hairs on and between veins; *upper surface* of costae bearing hairs less than 1 mm long, scattered similar hairs on costules and veins, surface between veins covered with fine appressed hairs. *Sori* medial, basal ones much divergent; indusia small with copious long hairs; sporangia setiferous.

Distr. *Malesia*: W. New Guinea (near Lake Habbema), only known from the type.

Ecol. On dry face of limestone wall, in shade.

**152. *Sphaerostephanos wauensis* HOLTUM, sp. nov.**

*Pinnae redactae usque 9-jugatae, infimae 5  $\times$  4 mm, superiores 1.4  $\times$  1.0 cm, triangulares; pinnae evolutae usque 12  $\times$  2.0 cm. 2/5 costam versus lobatae; rachis utrinque pilis patentibus brunneis 1 mm vel ultra longis pilisque brevioribus vestita; costae costulae venaque subtus pilis pallidis 1 mm longis praeditae, eglandulosae; indusia magna, tenuia, pilis brevibus instructa; sporangia setifera.*—Type: T. NAKAIKE 96, N.E. New Guinea, Morobe Distr., Wau, Mt Missim 1300–1600 m (K; TNS).

*Caudex* massive, suberect. *Stipe* 17 cm long; basal scales narrow, 7 mm or more long; base of stipe to first large pinna 55 cm. *Reduced pinnae* to 9 pairs, alternate; basal ones  $5 \times 4$  mm, uppermost  $1.5 \times 1.0$  cm, triangular with symmetric base, crenate; one pair intermediate pinnae present. *Lamina* 60 cm long; pinnae 21 pairs; lower pinnae slightly narrowed towards base which may be slightly auricled both sides; aerophores not elongate. *Rachis* bearing on both sides spreading thick brown hairs more than 1 mm long (sometimes lacking on lower surface), on lower surface also short erect pale hairs, on upper surface short brown hairs. *Largest pinnae*  $12 \times 2.0$  cm, sessile; base broadly cuneate to subtruncate, not dilated; apex short-acuminate; edges lobed rather less than  $\frac{1}{2}$  way to costa; lobes oblique and slightly falcate; costules 4–5 mm apart, at  $60^\circ$  or a little less; veins to 8 pairs,  $1\frac{1}{2}$  pairs anastomosing and 1 pair to sinus-membrane; *lower surface* of costae bearing many spreading pale hairs more than 1 mm long with a varied range of shorter ones, hairs on costules and veins sparse, to 1 mm long, short erect hairs between veins; *upper surface* of costae bearing slender pale hairs 1 mm long, similar hairs scattered on costules and veins, short appressed hairs on surface between veins not abundant. *Sori* inframedial, lower ones not divergent; indusia rather large, thin, bearing hairs 0.3 mm long; sporangia setiferous.

Distr. *Malesia*: Papua New Guinea (Morobe District), at 1300–1800 m, several collections.

Note. A smaller plant has fertile pinnae  $6.8 \times 1.3$  cm which are slightly stalked (WOMERSLEY & MILLAR 8309, from 1800 m), otherwise agreeing with the type.

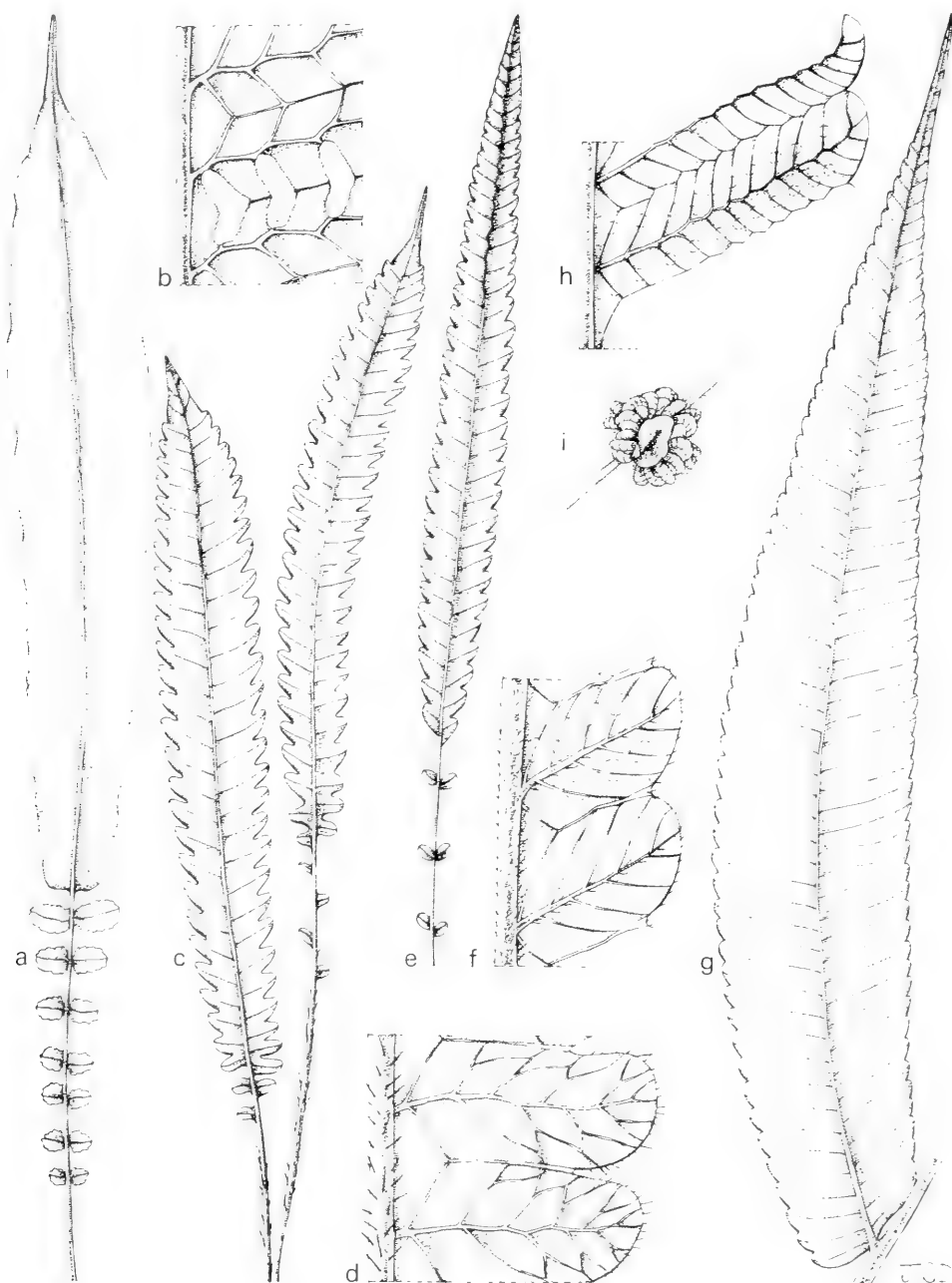


Fig. 14. *Pronephrium womersleyi* HOLTUM. a. Frond,  $\times \frac{1}{2}$ ; b. venation and position of sori in apical lamina,  $\times 3$ . — *P. heterophyllum* (PR.) HOLTUM. c. Fertile and sterile fronds,  $\times \frac{1}{2}$ ; d. venation of part of apical lamina,  $\times 3$ . — *P. micropinnatum* HOLTUM. e. Frond,  $\times \frac{1}{2}$ ; f. part of apical lamina,  $\times 4$ . — *P. asperum* (PR.) HOLTUM. g. One pinna,  $\times \frac{1}{2}$ ; h. venation and position of sori,  $\times 2$ ; i. one sorus,  $\times 16$  (a NAKAIKE 69, b BRASS 31670, c-d PRICE & HERNAEZ 162, e-f cult. Kew, g-i HENDERSON 21863).

## 18. PRONEPHRIUM

PRESL, Epim. Bot. (1851) 258, excl. *P. lastreoides* PRESL; HOLTUM, Novit. Bot. Inst. Bot. Univ. Carol. Prag. 1968 (1969) 48; Blumea 19 (1971) 34; Blumea 20 (1972) 105–126. — Type species: *Pronephrium lineatum* (BL.) PRESL, l.c. (designated by HOLTUM, l.c. 1969).

*Haplodictyum* PRESL, l.c. 50; CHING, Sunyatsenia 5 (1940) 251, p.p.; COPEL. Fern Fl. Philip. (1960) 377; HOLTUM, Blumea 19 (1971) 37; Kalikasan 2 (1973) 59, excl. *H. majus*. — *Thelypteris* subg. *Haplodictyum* K. IWATS. Mem. Coll. Sci. Univ. Kyoto B, 31 (1964) 32. — Type species: *Haplodictyum heterophyllum* PRESL, l.c.

*Abacopteris* FÉE, Gen. Fil. (1852) 309; CHING, Bull. Fan Mem. Inst. Biol. Bot. 8 (1938) 230; Acta Phytotax. Sinica 8 (1963) 331; HOLTUM, Rev. Fl. Malaya 2 (1955) 285, excl. *A. peltochlamys* (C. CHR.) HOLTUM. — *Dryopteris* sect. *Abacopteris* C. CHR. Gard. Bull. Str. Settl. 7 (1934) 247. — *Thelypteris* subg. *Abacopteris* K. IWATS. Mem. Coll. Sci. Univ. Kyoto B, 31 (1964) 34. — Type species: *Abacopteris philippinarum* FÉE, l.c. (designated by HOLTUM, l.c. 1969) = *Pronephrium asperum* (PRESL) HOLTUM.

*Dimorphopteris* TAGAWA & K. IWATS. Acta Phytotax. Geobot. 19 (1961) 8. — Type species: *Dimorphopteris moniliformis* TAGAWA & K. IWATS. l.c. — Fig. 1n–o, 14–16.

Caudex creeping or suberect (never truly erect); fronds simple or simply pinnate, basal pinnae not reduced but often narrowed at base on basiscopic side, less often on acroscopic; apical lamina pinna-like or widened towards its base and then merging with the upper pinnae; pinnae crenate to entire; veins several pairs (except in a few species with small pinnae), almost all anastomosing, the excurrent veinlets arising from their union in some species free, more often joining to form zig-zag composite veins alternating with the costules; sinus-membranes short or (in species with entire pinnae) lacking; lower surface of old fronds usually pustular when dried; acicular hairs usually present on lower surfaces, hooked in sect. *Grypothrix*; sessile spherical yellow glands present on lower surface, indusia and/or sporangia in some species; sori in some species exindusiate and then often spreading along the veins; sporangia often bearing short setae, less often spherical glands or both glands and setae; spores of most species with a  $\pm$  continuous longitudinal wing and cross-wings, three species with many small separate wings or papillae.

Distr. India & Ceylon; from S. China southwards throughout Malesia; North Queensland; Solomon Islands, New Hebrides, Fiji; c. 68 species, of which 12 not Malesian.

Ecol. Most species are terrestrial in forest or on stream-banks in shade (in several cases on rocks only); two are limestone ferns in more exposed positions (*P. simillimum*, *P. scopulorum*).

Cytol. Chromosome number 36; 10 species investigated, of which *P. pentaphyllum*, *P. peltatum* var. *peninsulare*, *P. womersleyi* and *P. triphyllum* are tetraploid.

Taxon. CHRISTENSEN (Ind. Fil. 1905) accepted *Abacopteris* FÉE (which he included in *Dryopteris*) as published in 1843, but that publication consisted of the generic name only with no description. CHING gave generic status to *Abacopteris*, and cited *Aspidium lineatum* BL. as type, but FÉE did not mention that species when the generic name was validly published by him in 1852; he then listed *Pronephrium* PRESL as a genus not adopted, as he had seen none of the species (p. 358).

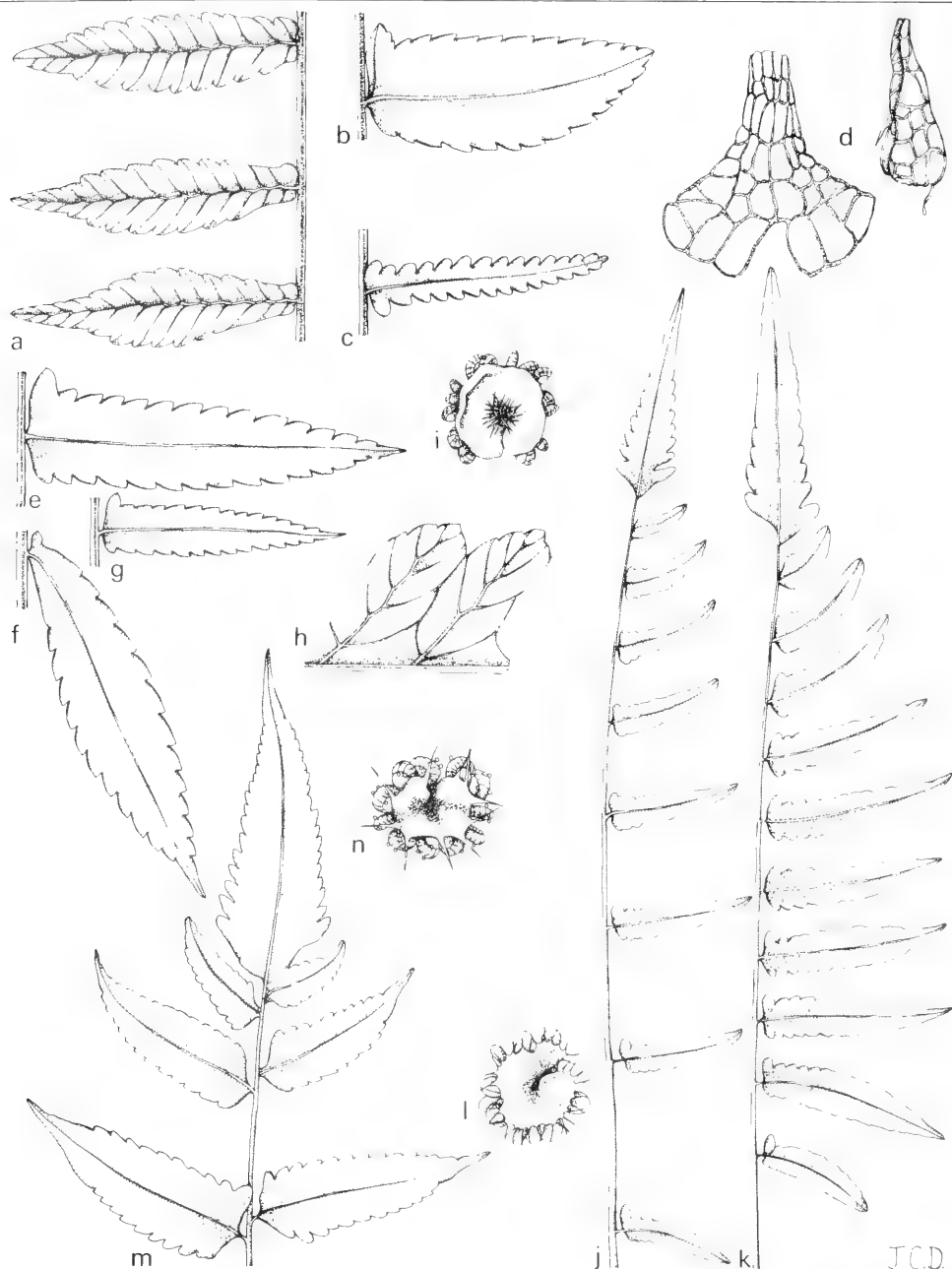


Fig. 15. *Pronephrium ambainense* (WILLD.) HOLTUM. *a*. Lower pinnae,  $\times \frac{2}{3}$ . — *P. celebicum* (BAK.) HOLTUM. *b*. Sterile pinna,  $\times 1.5$ ; *c*. fertile pinna,  $\times 1.5$ ; *d*. two indusia,  $\times 100$ . — *P. hewittii* (COPEL.) HOLTUM. *e*. Middle sterile pinna,  $\times 1.5$ ; *f*. basal sterile pinna,  $\times 1.5$ ; *g*. fertile pinna,  $\times 1.5$ ; *h*. venation of sterile pinna,  $\times 4$ ; *i*. sorus,  $\times 16$ . — *P. rhombeum* (CHRIST) HOLTUM. *j*. Fertile frond,  $\times \frac{2}{3}$ ; *k*. sterile frond,  $\times \frac{2}{3}$ ; *i*. sorus,  $\times 16$ . — *P. granulosum* (PR.) HOLTUM. *m*. Fertile frond,  $\times \frac{2}{3}$ ; *n*. sorus,  $\times 24$  (a from photo of type, b DRANSFIELD 3776, c–d CURTIS 431, e–i MOLESWORTH ALLEN 3048, j–n cult. Kew).



*Pronephrium* PRESL (1851) comprised four species, which I discussed in 1969, citing *P. lineatum* (BL.) PRESL as type and accepting the statement by METTENIUS and CHRISTENSEN that the second species *P. affine* (BL.) PRESL was not distinct from the first. Subsequently (HOLTTUM 1971) I examined the types of both of BLUME's species and found them to be quite distinct from each other. The third of PRESL's species is here named *P. rhombeum*; the fourth (*P. lastreoides* PRESL) is here transferred to *Sphaerostephanos*.

PRESL's most distinctive character is dimorphism of fertile and sterile fronds; this is doubtfully true of *P. lineatum* (the fertile frond of the type is not fully expanded) but is true of species 2 and 3. FÉE distinguished *Abacopteris* mainly by subentire pinnae with meniscioid venation but the excurrent veinlets not free, and indusiate sori. CHING (1938) extended it to admit species in mainland Asia with exindusiate sori and typical meniscioid venation; he also cited absence of sinus-membranes as a generic character, but short membranes are often present (the line of distinction is not a sharp one). CHRISTENSEN (1934) had already added species from Malesia as *Dryopteris* sect. *Abacopteris*. In 1971 and 1972, under the earlier name *Pronephrium*, I accepted the generic concepts of CHING and CHRISTENSEN, adding the character absence of reduced basal pinnae, and divided the whole into three sections: *Pronephrium*, *Dimorphopteris* and *Grypothrix*. But some of the species then placed in *sect. Pronephrium* have resemblances to species in *sect. Dimorphopteris* and some to species in *sect. Grypothrix*. I here attempt to adjust this situation by re-arranging the species in two subgenera *Pronephrium* and *Menisciopsis*. *Haplodictyum* PRESL (which I treated as a separate genus in 1971) is included in *sect. Pronephrium*. But though sections *Dimorphopteris* and *Grypothrix*, as re-arranged, appear to be natural groups, the other two sections are probably not; problems of relationships are discussed under the sections.

#### KEY TO THE SUBGENERA AND SECTIONS

1. Veins in pinnae less than 10 pairs, or if more than 10, sori indusiate; yellow spherical glands often present, at least on sporangia . . . . . 1. SUBG. PRONEPHRIUM
2. Apical lamina pinna-like or much larger than pinnae; pinnae not auricled on acroscopic base; fronds of young plants simple, in *P. beccarianum* all fronds simple . . . . . 1. Sect. *Pronephrium*
2. Apical lamina not pinna-like, or if so pinnae auricled on acroscopic base; fronds of young plants rarely simple . . . . . 2. Sect. *Dimorphopteris*
1. Veins in pinnae 10 pairs or more, or if fewer, excurrent veinlets all free; sori exindusiate; spherical glands never present . . . . . 2. SUBG. MENISCIOPSIS
3. No hooked hairs on any part of plant; sori rarely coalescent . . . . . 3. Sect. *Menisciopsis*
3. Hooked hairs present on sporangia or on some other part of plant; sori often elongate or coalescent . . . . . 4. Sect. *Grypothrix*

### 1. Subgenus *Pronephrium*

#### 1. Section *Pronephrium*

*Haplodictyum* PRESL, Epim. Bot. (1851) 50.

The following species, included here in 1972, are now transferred to other sections: the non-Malesian *P. lakhimpurens* and allied species, also the Malesian *P. nitidum*, *P. repandum* and *P. acanthocarpum*, to *sect. Menisciopsis*; *P. aquatiloides* and *P. menisciicarpon* to *sect. Dimorphopteris*.

The species here included belong to three groups:

1. Species which appear to be related to the type, *P. lineatum*. Of these, *P. euryphyllum* has glands on the lower surface and appressed hairs on the upper surface as in *P. glandulosum* of *sect. Dimorphopteris*. *P. asperum* and *P. gymnopteridifrons* lack glands but have the same frond-form as the type. None of these have the reddish tinge shown by species of *subg. Menisciopsis*. But they show resemblances to *Sphaerostephanos peltoclamys*, *S. simplicifolius* and *S. spenceri*, which differ only in the presence of several pairs of much-reduced basal pinnae.

2. Species which have an elongate apical lamina and a few much smaller pinnae, and sori which lack indusia. These are specialized forms the relationship of which it is difficult to suggest. Three of them have glands on their sporangia as in *P. lineatum*. The most aberrant species, lacking glands, is *P. micropinnatum*; it may belong elsewhere.

3. Species included in *Haplodictyum* in my arrangement of the genera in 1971, but excluding *H. majus* COPEL. which is now placed in *Sphaerostephanos* because it has much-reduced basal pinnae in addition to normal ones. These species have glands on the lower surface of pinnae and indusiate sori.

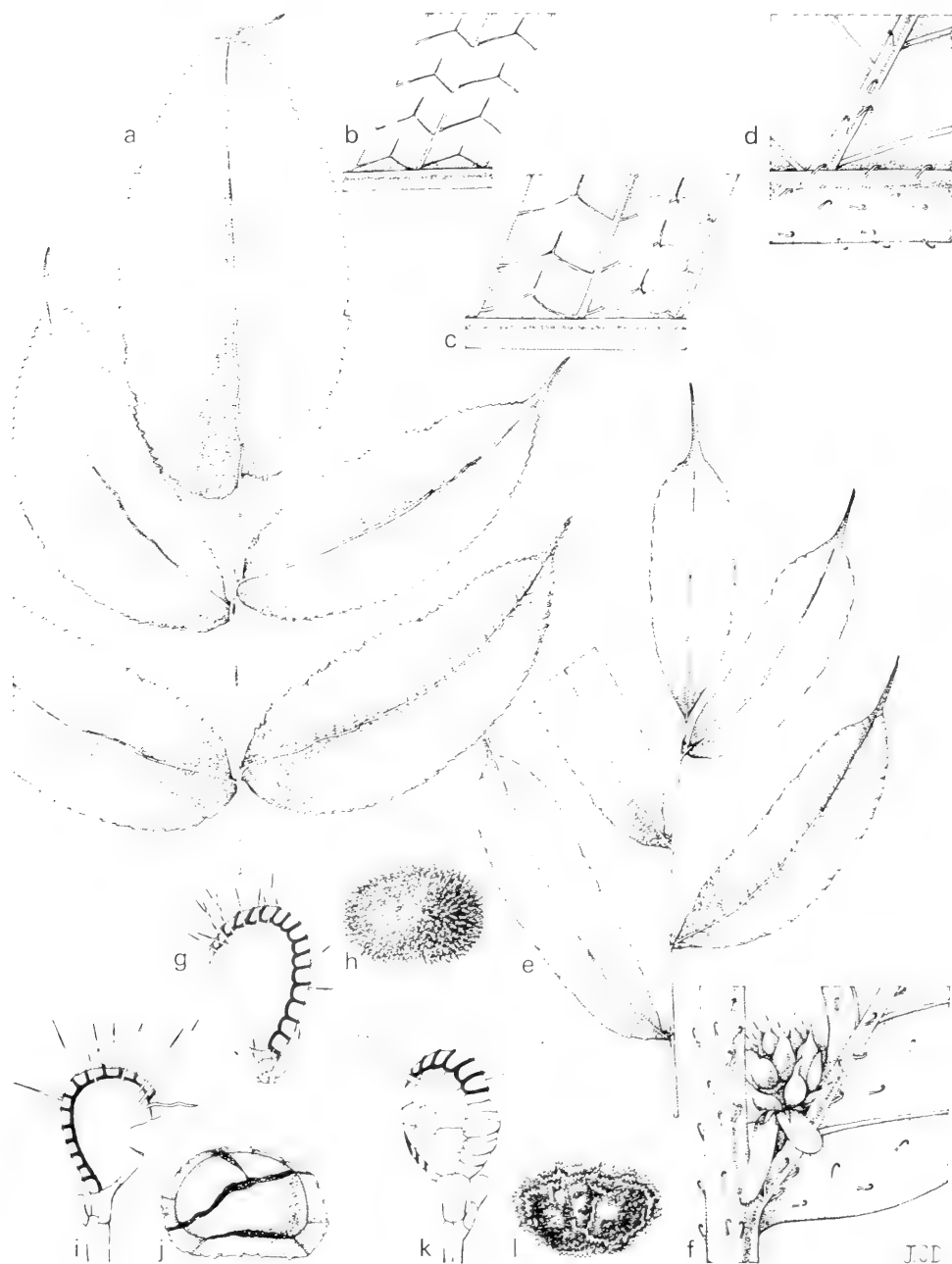


Fig. 16. *Pronephrium rubicundum* (v.A.v.R.) HOLTUM. a. Complete frond,  $\times \frac{1}{2}$ ; b. venation of sterile frond,  $\times 3$ ; c. venation of fertile frond and position of sori,  $\times 4$ ; d. costa and costule showing hooked hairs,  $\times 12$ . — *P. ramosii* (CHRIST) HOLTUM. e. Upper part of frond,  $\times \frac{1}{2}$ ; f. bud at base of a pinna,  $\times 8$ . — Sporangia,  $\times 35$ , and spores,  $\times 235$ : g–h. *P. nitidum* HOLTUM; i–j. *P. repandum* (FÉE) HOLTUM; k–l. *P. triphyllum* (Sw.) HOLTUM (a–d MATTHEW s.n., e–f ELMER 17851, g–l after HOLTUM, Blumea 19: 24, fig. 8–9 and SEM photos).

Two of them have the peculiar venation in their terminal lamina which caused PRESL to establish the genus *Haplodictyum*: the veins in the lower part of the apical lamina are forked, their branches anastomosing to form a series of areoles along the costules, also sometimes additional areoles below the sinuses. This venation resembles that of *Pleocnemia*, and on that account CHING placed *Haplodictyum* in his family *Aspidiaceae*, though it is unquestionably thelypteroid. But the third species (*P. bakeri*) does not have the veins thus forked, though in every other character it resembles the other two. The *Haplodictyum* type of venation occurs to a small extent at the base of the apical lamina in several species of other genera of *Thelypteridaceae* where the transition from apical lamina to pinnae is not sharply defined. The peculiar venation is like that of pinnae, of which the upper ones are more or less adherent to the base of the apical lamina. There is a North American fossil named *Goniopteris claiborniana* BERRY (Bull. Torr. Bot. Cl. 44, 1917, 331, t. 22) which shows the *Haplodictyum* venation.

## KEY TO THE SPECIES

1. Pinnae of fronds of adult plants about equal in size to apical lamina.
  2. Glands present on lower surface of pinnae . . . . . 1. *P. euryphyllum*
  2. Glands lacking on lower surface of pinnae.
    3. Pinnae 2-3 pairs; glands present on indusia or sporangia or both . . . . . 2. *P. lineatum*
    3. Pinnae to at least 7 pairs; no glands on indusia and sporangia.
      4. Pinnae to 30 × 5 cm; spores with a median wing and cross-wings . . . . . 3. *P. asperum*
      4. Pinnae to 15 × 2.5 cm; spores with many separate small wings . . . . . 4. *P. gymnopteridifrons*
1. Apical lamina much larger than pinnae, or fronds simple.
  5. Sori exindusiate; glands usually lacking on lower surface between veins.
    6. No free pinnae; sometimes one small pair broadly adnate . . . . . 5. *P. beccarianum*
    6. Free pinnae present on adult plants.
      7. Sporangia bearing glands near annulus.
        8. Apical lamina to 20 × 3.5 cm; midrib of apical lamina and rachis glabrous on lower surface . . . . . 6. *P. womersleyi*
        8. Apical lamina to 6 × 1.7 cm; hairs present on lower surface of midrib of apical lamina and rachis . . . . . 7. *P. melanophlebium*
      7. Sporangia bearing setae, not glands, near annulus.
        9. Terminal lamina lobed 1/4-1/3 towards midrib; pinnae to at least 1 cm long.
          10. Pinnae 4-8 cm long . . . . . 8. *P. pentaphyllum*
          10. Pinnae not over 2 cm long.
            11. No glands on lower surface . . . . . 9. *P. brauseanum*
            11. Glands present on lower surface . . . . . 10. *P. diminutum*
        9. Terminal lamina crenate; pinnae 2-5 mm long . . . . . 11. *P. micropinnatum*
    5. Sori indusiate; glands always present on lower surface between veins.
      12. Veins in basal part of apical lamina forked, their branches anastomosing.
        13. Apical lamina widest near its base; pinnae 1 pair . . . . . 12. *P. bulusanicum*
        13. Apical lamina not widest near its base; pinnae 3 pairs, decreasing downwards . . . . . 13. *P. heterophyllum*
      12. Veins in apical lamina not forked . . . . . 14. *P. bakeri*

1. *Pronephrium euryphyllum* (ROSENST.) HOLT-TUM, Blumea 20 (1972) 112. — *Dryopteris euryphylla* ROSENST. Meded. Rijks herb. n. 31 (1917) 7. — *Thelypteris euryphylla* (ROSENST.) REED, Phytologia 17 (1968) 276. — Type: KORTHALS, Sumatra (L; B).

*Dryopteris urophylla* var. *teysmannii* v.A.v.R. Bull. Jard. Bot. Btzig II, 28 (1918) 24. — Type: TEYSMANN, Sumatra, Loeboe Alang (BO?; not found).

*Sterile fronds* unknown. *Fertile fronds* consisting of terminal lamina to 21 × 5.5 cm and at least 3 pairs of pinnae. *Pinnae* to 18 × 6 cm, base broadly cuneate, sides parallel for most of their length, crenate to depth of 1-1.5 mm, apex abruptly narrowed to a cusp 1-2 cm long; costules 4-4.5 mm apart, at more than 60° to costa, slightly falcate;

veins c. 15 pairs, almost all anastomosing, excurrent veinlets not free; lower surface of rachis, costae and costules covered densely with short erect hairs, similar shorter hairs with many glands on surface between veins; upper surface densely covered throughout with short appressed hairs. *Sori* supramedial, spreading a little along veins; indusia hairy, persistent but shrivelling; sporangia bearing several short setae; spores pale, with continuous wing and cross-wings.

*Distr. Malesia*: Sumatra; the two types cited.

*Notes.* The KORTHALS collection at L consists of 5 sheets (2 also at B); on one of the smaller fronds the basal pinnae are somewhat reduced and narrowed at their base, but the lowest (of three pairs) on the largest specimen are not, so that there may have been more pairs of pinnae on

the latter. VAN ALDERWERELT's short description of TEYSMANN's specimen is adequate for identification; the number of pairs of pinnae is not specified.

2. *Pronephrium lineatum* (BL.) PRESL, Epim. Bot. (1851) 259; HOLTUM, Blumea 19 (1971) 34; 20 (1972) 112. — *Aspidium lineatum* BL. Enum. Pl. Jav. (1828) 144; METT. Farngatt. IV (1858) 264, p.p. — *Meniscium lineatum* (BL.) KUNZE, Bot. Zeit. 6 (1848) 259. — *Nephrodium lineatum* (BL.) PRESL, Epim. Bot. (1851) 48; HOOK. Spec. Fil. 4 (1862) 74, p.p. — *Cyclosorus lineatus* (BL.) TARD. & C. CHR. Notul. Syst. 7 (1938) 74, *nomen tantum*. — *Abacopteris lineata* (BL.) HOLTUM, Rev. Fl. Malaya 2 (1955) 292, *nomen tantum*. — *Thelypteris lineata* (BL.) K. IWATS. Mem. Coll. Sci. Univ. Kyoto B, 31 (1964) 34. — Type: BLUME, Java (L. n. 909, 27–60; isotypes P, PRC).

*Alsophila fragilis* ZOLL. & MORITZI, Nat. Geneesk. Arch. Ned. Ind. 1 (1844) 400. — *Meniscium* sp. MORITZI, Syst. Verz. (1846) 116. — *Meniscium fragile* (ZOLL. & MOR.) KUNZE, Bot. Zeit. 6 (1848) 259. — Type: ZOLLINGER 1019, Java, Tjikoya river (L; FI).

*Dryopteris verruculosa* v.A.v.R. Bull. Jard. Bot. Btzig II, 11 (1915) 12; Handb. Suppl. (1917) 177. — *Thelypteris verruculosa* (v.A.v.R.) REED, Phytologia 17 (1968) 323. — Type: BACKER 3954, Java, Pasuruan (BO).

*Dryopteris menisciocarpa* (BL.) POSTH. in Backer & Posth. Varenfl. Java (1939) 61, p.p.

*Caudex* short-creeping or suberect. *Stipe* of sterile frond 20 cm, of fertile 40 cm long, pale, glabrescent except for hairs in groove. *Sterile frond*. Apical lamina to 15 × 4 cm; pinnae 2–3 pairs, to 9.5 × 3.0 cm, widest 1/3 from apex, gradually narrowed to abruptly broad-cuneate base, apex rather abruptly short-cuspidate, edges crenate distally, sinuous towards base; costules 3 mm apart; veins 7–8 pairs, almost all anastomosing, excurrent veinlets not free; *lower surface* with rather sparse erect hairs on costae, much shorter on costules, surface between veins glabrous and finely pustular, no glands present; *upper surface* hairy on costae only. *Fertile pinnae* of type not fully expanded, largest possibly 3.0 × 1.5 cm, of ZOLLINGER 1019 9 × 2.5 cm, of BACKER 3954 7 × 2.2 cm; sori inframedial; indusia small, bearing a few short hairs and glands; sporangia with glands, or both glands and setae; spores with translucent wing and cross-wings.

*Distr. Malesia*: Central & East Java (3 collections) and Sabah (Bettotan, KLOSS SFN 19083); Sulu Archipelago, Tawi-Tawi (ALCASID & CELESTINO PNH 7507).

*Notes*. METTENIUS (1858) included *Aspidium affine* BL. as a synonym, and his description is composite; HOOKER (1862) copied him; later authors mostly described *A. affine* under the name *lineatum*, not noticing that BLUME's descriptions

of the two species indicate fronds of quite different form.

BLUME gave Noesa Kambangan as type locality, but the only specimen named in his hand is unlocalized; it agrees well with his description. The published description of *Alsophila fragilis* ZOLL. & MOR. is doubtfully valid, but the specimens of ZOLLINGER 1019 certainly agree with BLUME's. The sporangia of the type have both glands and setae; those of ZOLLINGER 1019 glands only.

3. *Pronephrium asperum* (PRESL) HOLTUM, Blumea 20 (1972) 112. — *Polypodium asperum* PRESL, Rel. Haenk. (1825) 24, t. 3, f. 4, *non LINN.*; HOLTUM, Novit. Bot. Inst. Bot. Univ. Carol. Prag. 1968 (1969) 18. — *Goniopteris aspera* PRESL, Tent. Pterid. (1836) 183, *nom. nov.* — *Aspidium asperum* (PRESL) METT. Ann. Mus. Bot. Lugd.-Bat. 1 (1864) 225, *excl. syn.* *Nephrodium latifolium* PRESL. — *Dryopteris presliana* CHING in C. CHR. Ind. Fil. Suppl. 3 (1934) 95, *nom. nov. superfl.* — *Abacopteris presliana* (CHING) CHING, Bull. Fan Mem. Inst. Biol. Bot. 8 (1938) 248, p.p. — *Abacopteris aspera* CHING, Acta Phytotax. Sinica 8 (1963) 332. — *Thelypteris aspera* REED, Phytologia 17 (1968) 261. — Type: HAENKE, Luzon (PRC).

*Abacopteris philippinarum* FÉE, Gen. Fil. (1852) 310, t. 18C f. 1. — *Cyclosorus philippinarum* (FÉE) COPEL., Fern Fl. Philip. (1960) 372. — *Nephrodium latifolium* PRESL, Epim. Bot. (1851) 45, p.p. — Type: CUMING 16, Luzon (isotypes BM, G, K, LE).

*Meniscium kennedyi* F.v.M. Fragm. 4 (1864) 165. — *Goniopteris kennedyi* (F.v.M.) BAILEY, Handb. Queensl. Ferns (1874) 41, f. 31. — Type: DALLACHY & KENNEDY, Rockingham Bay, Queensland (MEL; K).

*Dryopteris urophylla* (WALL. ex HOOK.) C. CHR. var. *novoguineensis* ROSENST. in Fedde Rep. 10 (1912) 336; v.A.v.R. Handb. Suppl. (1917) 177. — Type: G. Bamler 80, Sattelberg, New Guinea (orig. not seen; probable isotypes BM, L, W, as Rosenst. fil. novoguine. exsic. 174).

*Abacopteris multilineata* (WALL. ex HOOK.) CHING var. *malayensis* HOLTUM, Rev. Fl. Malaya 2 (1955) 297, f. 173, *nom. illeg.* — *Thelypteris multilineata* (WALL. ex HOOK.) CHING var. *malayensis* (HOLTUM) REED, Phytologia 17 (1968) 294 (type not cited). — Lectotype: HOLTUM SFN 15303, Trengganu, Kuala Telumong (SING; K).

*Aspidium repandum sensu* BL. Enum. Pl. Jav. (1828) 144, *excl. syn.*

*Nephrodium glandulosum sensu* J. SM. in Hook. J. Bot. 3 (1841) 411 (misidentification of CUMING 16); DIELS in E. & P. Nat. Pfl. Fam. I Abt. 4 fig. 92G "nach Fée" (inaccurate copy of FÉE, Gen. Fil. t. 18C, f. 1). — *Aspidium glandulosum sensu* KUNZE, Bot. Zeit. 6 (1848) 260, *quoad* Cuming 16

*tantum*; METT. Farngatt. IV (1858) 111, *quoad* syn. *Abacopteris philippinarum* FÉE *tantum*.

*Polypodium urophyllum* sensu BENTH. Fl. Austral. 7 (1878) 766, excl. BEDD. Ferns Brit. Ind. t. 3. — *Nephrodium urophyllum* sensu BEDD. Handb. (1883) 274, p.p.; sensu RACIB. Fl. Btzig 1 (1898) 184. — *Dryopteris urophylla* sensu v.A.v.R. Handb. (1908) 216, p.p.; sensu BACKER & POSTH. Varenfl. Java (1939) 64, p.p. — Fig. 14g-i.

*Caudex* short-creeping. *Stipe* to 70 cm or more long, slightly flushed red, glabrescent, base at first covered with narrow thin scales. *Lamina* to 60 cm or more long; pinnae 6-8 pairs, lower ones  $\pm$  narrowed at base, lowest sometimes reduced, texture thin; apical lamina more strongly crenate than pinnae. *Largest pinnae* to  $37 \times 6$  cm, sessile, base abruptly broad-cuneate, apex short-acuminate, edges subentire to distinctly crenate, parallel for most of their length; costules 5-5.5 mm apart, at  $60^\circ$  to costa; veins 12-15 pairs, at c.  $45^\circ$ , nearly all anastomosing, excurrent veinlets usually not free; sinus-membrane short but distinct; lower surface of costae, costules and veins bearing short hairs, surface between veins glabrous or rarely with short erect hairs, finely verrucose when dry; upper surface hairy only on costa. *Sori* medial, lowest ones supramedial and  $\pm$  coalescent; indusia small, with or without short hairs; sporangia of type lacking setae, a hair of 2 cells on the stalk; spores dark with a continuous wing and cross-wings.

*Distr.* Polynesia (Fiji), Solomon Is. (Bougainville), North Queensland and throughout *Malesia*. *Ecol.* In lowland forest.

*Notes.* Until the work of CHING (1938) this species and others were much confused with *Polypodium urophyllum* WALL. (= *Pronephrium repandum* (FÉE) HOLTUM), the present species also with *Nephrodium latifolium* PRESL (= *Pronephrium menisciocarpon*) and *Aspidium glandulosum* BL. (*Pronephrium glandulosum*); under the last-named METTENIUS also cited specimens of *Sphaerostephanos peltoclamys* (C. CHR.) HOLTUM (ZOLLINGER 2608, 2920). Specimens from New Guinea and Queensland often have 1-2 short setae on sporangia.

**4. *Pronephrium gymnopteridifrons*** (HAYATA) HOLTUM, Blumea 20 (1972) 112; C. M. KUO, Fl. Taiwan 1 (1975) 429, pl. 150; EDIE, Ferns Hong Kong (1978) 151, f. 73. — *Dryopteris gymnopteridifrons* HAYATA, Ic. Pl. Formos. 8 (1919) 148, fig. 75, 76. — *Abacopteris gymnopteridifrons* (HAYATA) CHING, Bull. Fan Mem. Inst. Biol. Bot. 8 (1938) 251. — Type: T. SOMA s.n. 1912, Taiwan (isotypes TAI).

*Polypodium urophyllum* var. *uniseriale* HOOK. Spec. Fil. 5 (1863) 10, new name for *Polypodium granulosum* sensu BENTH. Fl. Hongkong (1861) 459. — Lectotype (HOLTUM l.c. 1972): URQUHART, Hong Kong (K).

*Cyclosorus pustulosus* COPEL. Philip. J. Sci. 81

(1952) 37; Fern Fl. Philip. (1960) 374. — *Thelypteris pustulosa* (COPEL.) REED, Phytologia 17 (1968) 307. — Type: Copeland 218, Lamao River, Luzon (MICH).

*Dryopteris glandulosa* sensu CHR. Philip. J. Sci. 2 (1907) Bot. 205, p.p.

*Abacopteris presliana* sensu CHING, Bull. Fan Mem. Inst. Biol. Bot. 8 (1938) 249, p.p.

Differs from *P. asperum* as follows. *Caudex* (at least in some cases) long-creeping; frond smaller, pinnae commonly to  $15 \times 2.5$  cm (exceptionally to  $25 \times 4$  cm); sori more often coalescent (in some cases many pairs); sporangia often setiferous; spores with many small wings.

*Distr.* Southern China and *Malesia*: Philippines (Luzon).

**5. *Pronephrium beccarianum*** (CESATI) HOLTUM, Blumea 20 (1972) 107; BROWNLIE, Pterid. Fiji (1977) 256, pl. 26, f. 2. — *Meniscium beccarianum* CESATI, Rendic. Acad. Napoli 16 (1877) 27, 30. — *Dryopteris cesatiana* C. CHR. Ind. Fil. (1905) 257, nom. nov. (not *D. beccariana* (CESATI) C. CHR.); COPEL. Bishop Mus. Bull. 59 (1929) 48. — *Phegopteris beccariana* (CESATI) v.A.v.R. Handb. (1908) 509. — *Cyclosorus beccarianus* (CESATI) COPEL. Gen. Fil. (1947) 142; Philip. J. Sci. 78 (1951) 460. — *Thelypteris cesatiana* (C. CHR.) REED, Phytologia 17 (1968) 267 (not *T. beccariana* (CESATI) REED). — Type: Beccari, Andai, W. New Guinea (FI, Herb. Becc. 12727).

*Goniopteris simplicifolia* (J. SM. ex HOOK.) CARR. var. *vitiensis* CARR. in Seem. Fl. Vitiensis (1893) 366. — Type: SEEMANN 736, Fiji (K).

*Dryopteris oblanceolata* COPEL. Philip. J. Sci. 9 (1914) Bot. 3. — *Phegopteris oblanceolata* (COPEL.) v.A.v.R. Handb. Suppl. (1917) 320. — Type: C. KING 394, Taupota, Papua (MICH; SING).

*Phegopteris ruteniana* v.A.v.R. Bull. Jard. Bot. Btzig II, 28 (1918) 36. — Type: KORNASSI 725, Ceram (BO).

*Caudex* short-creeping. *Stipe* 2-10 cm long, usually longest in fertile fronds, near base minutely hairy, above base hairy in groove. *Lamina* simple, to 35 cm long, sterile to 5 cm wide, fertile usually narrower, widest 1/3 from short-acuminate apex, very gradually narrowed to base, edges entire or sinuous, base sometimes dilated or with a pair of small broadly adnate separate leaflets; main veins 3.5-4 mm apart, at broad angle to midrib, distally upcurved; veins 9-10 pairs, almost all anastomosing, excurrent veinlets mostly not free; lower surface between veins pustular, sparse short hairs present on main veins and veins, sometimes also rudimentary scales with red end-cell; upper surface short-hairy on midrib, sparsely on main veins. *Sori* exindusiate, spreading along veins, those on connivent veins often joining, sori rarely extending a little along excurrent veinlets; sporangia bearing small

glands and sometimes a short seta; spores pale with rather broad minutely erose translucent wing and a few cross-wings.

Distr. Polynesia (Fiji), Solomon Is., in *Malesia*; New Guinea and Moluccas (Ceram).

Ecol. In forest, usually near streams, to 1000 m or a little higher.

Notes. In Fiji the basal part of the lamina is more often strongly sinuous and there may be 3 pairs of broadly adnate basal leaflets; glands on sporangia are larger than in New Guinea.

**6. *Pronephrium womersleyi* HOLTUM**, *Blumea* 20 (1972) 108. — *Cyclosorus beccarianus sensu* HOLTUM & ROY, *Blumea* 13 (1965) 134. — Type: FLOYD & WOMERSLEY NGF 6308, N.E. New Guinea, Eastern Highlands, Goroka Subdistr. 2200 m (LAE; BM). — Fig. 14a–b.

Differs from *P. beccarianum* as follows. Adult plants always with several (to 10) pairs of free  $\pm$  orbicular pinnae 7–10 mm long, 7–8 mm wide; veins in pinnae forked, the branches joining to form a series of areoles; apical lamina smallest on fronds with most pinnae; lower surface of midrib and veins glabrous or nearly so; sori (on apical lamina only, or rarely on a pinna) on lower 1–3 pairs of veins coalescent, more distal sori on basal part of each vein; sporangia bearing small glands, not setae.

Distr. Solomon Is. (Guadalcanal), in *Malesia*: Papua New Guinea, 1400–2400 m.

Note. A plant cultivated at Kew was found to be tetraploid (HOLTUM & ROY l.c.).

**7. *Pronephrium melanophlebium* (COPEL.) HOLTUM**, *Blumea* 20 (1972) 108. — *Dryopteris melanophlebia* COPEL. *Philip. J. Sci.* 6 (1911) Bot. 147. — *Phegopteris melanophlebia* (COPEL.) v.A.v.R. *Handb. Suppl.* (1917) 319. — *Cyclosorus melanophlebius* (COPEL.) COPEL. *Fern Fl. Philip.* (1960) 359. — *Thelypteris melanophlebia* (COPEL.) REED, *Phytologia* 17 (1968) 292. — Type: MERRILL 6959, Canlaon Volcano, Negros (isotypes B, BO, E, K, L, NSW).

*Dryopteris canescens* var. *subsimplificifolia* CHRIST, *Philip. J. Sci.* 2 (1907) Bot. 199. — Type: WHITFORD 784, Luzon (not seen).

In habit similar to *P. womersleyi* but much smaller. *Stipe* 2–3 cm (sterile), to 8 cm (fertile), covered with hairs more than 0.5 mm long. *Apical lamina* of sterile fronds to 5  $\times$  1.8 cm, of fertile to 6  $\times$  1.4 cm; *pinnae* 3 pairs, sterile 6  $\times$  5 mm, fertile 5  $\times$  4 mm and more widely spaced than sterile, oblong-ovate with midrib and 4 pairs of forked veins, the branches anastomosing; *lower surface* of costa with copious spreading pale hairs to 1 mm long, sparse shorter hairs on veins; on *upper surface* a few short appressed hairs between veins, especially near margins; *sori* from base of veins,  $\pm$  elongate, exindusiate, those on connivent veins sometimes meeting; sporangia bearing glands.

Distr. *Malesia*: Philippines (Negros, Mindanao (ELMER 10784, Mt Apo), (?) Luzon).

Note. ELMER's specimen from Mindanao was distributed under the name *Dryopteris canescens* var. *subsimplificifolia*; it agrees with CHRIST's brief description of that variety, but ELMER 10278, also so named, is *Pronephrium granulosum*.

**8. *Pronephrium pentaphyllum* (ROSENST.) HOLTUM**, *Blumea* 20 (1972) 108. — *Dryopteris pentaphylla* ROSENST. in Fedde Rep. 12 (1913) 529. — *Phegopteris pentaphylla* (ROSENST.) v.A.v.R. *Handb. Suppl.* (1917) 317. — *Thelypteris pentaphylla* (ROSENST.) REED, *Phytologia* 17 (1968) 303. — Type: KEYSER 186, N.E. New Guinea, Sattelberg 1400 m (S-PA; B, BM).

*Caudex* long-creeping, 2–3 mm diameter when dry, with fronds 1–2 cm apart. *Stipe* of sterile frond c. 10 cm long, of fertile to 20 cm, bearing pale spreading hairs more than 0.5 mm long; *fronds* consisting of apical lamina and 1–2 pairs of pinnae. *Apical lamina* 10–15  $\times$  1.5–3.0 cm, lobed 1/3 towards midrib, narrowed slightly to  $\pm$  truncate base, apex acuminate; main veins c. 5 mm apart, veins to 10 pairs, 2 pairs anastomosing, 1½–2 pairs passing to long sinus-membrane; *lower surface* of midrib and veins bearing pale spreading hairs 1 mm long, rather sparse slender erect hairs between veins, no glands (but see note below); *upper surface* glabrous except for midrib. *Pinnae* opposite, 4–8 cm long, 1–2.5 cm wide (sterile wider than fertile), widest above middle, lobed 1/4–1/3 towards costa; veins 4–6 pairs; pubescence as apical lamina. *Sori* inframedial, spreading a little along the veins, basal ones only sometimes confluent; sporangia bearing 2–6 setae, on stalk a hair of 2 cells; spores pale, opaque, with rather broad translucent wing and cross-wings. *Chromosomes*:  $n = 72$  (T. G. WALKER).

Distr. *Malesia*: N.E. New Guinea (also New Ireland).

Ecol. In forests, 1200–2000 m.

Notes. One specimen from Mt Oga, Western Highlands (B. S. CROXALL 4362) differs from all others seen in having scattered yellow glands instead of hairs between veins on lower surface of sterile fronds, and a yellow spherical gland at tip of hair on stalk of sporangium; also in the presence of fairly abundant short suberect hairs between veins of upper surface.

**9. *Pronephrium brauseanum* HOLTUM**, *Blumea* 20 (1972) 107. — *Dryopteris canescens* var. *novoguineensis* BRAUSE, *Bot. Jahrb.* 49 (1912) 22; COPEL. *Philip. J. Sci.* 78 (1951) 460. — Type: SCHLECHTER 18844, N.E. New Guinea, Bismarck Mts 1100 m (B; K, L, BISH).

*Caudex* short-creeping; fronds dimorphous. *Sterile fronds*. *Stipe* 1.5–3 cm long; *frond* consisting of terminal lamina and 1–2 pairs of pinnae close below it; *terminal lamina* 5–6  $\times$  1.7–2.1 cm,

lobed 1/4 towards midrib, main veins 4–4.5 mm apart, veins 5–6 pairs, 1½ pairs anastomosing, 1 pair to sinus-membrane, strongly prominent on lower surface and bearing stiff hairs to 1 mm long, a few glands and short erect hairs present on surface between veins; upper surface bearing copious appressed hairs 0.3–0.4 mm long between veins; pinnae 1.0–2.0 cm long, 0.5–1.1 cm wide, sessile, edges crenate, pubescence as apical lamina. Fertile frond. Stipe to 12 cm long; pinnae more widely spaced than sterile, not opposite, to 1.2×0.6 cm with stalks 1 mm long, subentire with rounded apex, lowest pinna longest; sori (mainly on the terminal lamina) a little elongate, exindusiate; sporangia copiously setose.

Distr. *Malesia*: Eastern New Guinea at 1100–1700 m, in forest (5 collections).

**10. *Pronephrium diminutum* (COPEL.) HOLT-TUM**, *Blumea* 20 (1972) 115. — *Dryopteris diminuta* COPEL. Philip. J. Sci. 40 (1929) 298. — *Cyclosorus diminutus* (COPEL.) COPEL. Gen. Fil. (1947) 142; Fern Fl. Philip. (1960) 359. — Type: COPELAND s.n. Nov. 1911, Mindanao, San Ramon 1200 m (MICH).

*Caudex* creeping, 1 mm diameter; scales 2 mm long. *Stipe* of sterile fronds 1–3 cm long, of fertile to 6 cm, covered with short pale erect hairs; *frond* consisting of apical lamina and 1–2 pairs of pinnae (not opposite). *Sterile fronds*. *Apical lamina* 2–4 cm long, 1.5 cm wide, lobed 1/4 towards midrib; main veins 4–4.5 mm apart, veins 3–4 pairs, 1–2 pairs anastomosing, prominent on lower surface; lower surface of midrib bearing stiff pale hairs to 1 mm long, shorter hairs on veins with a few glands, slender erect hairs and a few glands on surface between veins; upper surface covered with slender appressed hairs; pinnae broadly ovate, and slightly lobed, to 8 mm long, on stalks more than 1 mm long. *Fertile fronds* somewhat smaller than sterile, with more widely-spaced pinnae; sori exindusiate, those on lower veins elongate and coalescing, on distal veins round; sporangia bearing several short setae distally and sometimes a yellow gland on the stalk.

Distr. *Malesia*: Philippines (Luzon, Mindanao).

Note. COPELAND made 2 collections at San Ramon, one earlier than the type (1907). The only other collection is by M. G. PRICE (n. 2720B) from Mt Banahaw, Luzon, at 1000 m "on rocky slope 10 m above stream"; it only differs from the type in slightly larger fronds with fertile pinnae to 1.1×0.8 cm.

**11. *Pronephrium micropinnatum* HOLT-TUM**, *Blumea* 20 (1972) 108. — Type: DARBYSHIRE & HOOGLAND 8014, N.E. New Guinea, Sepik Distr. (CANB; BM, L, LAE). — Fig. 14g–f.

*Caudex* short, suberect. *Stipe* to 6 cm long, minutely hairy on abaxial side, hairs in adaxial groove to 1 mm long. *Fronds* uniform, consisting

of terminal lamina and 2–3 pairs of pinnae 1–1.5 cm apart. *Terminal lamina* to 18×1.4 cm, narrowed both to apex and base, edges crenate; main veins 4–5 mm apart, each with 4–5 pairs of veins of which 1½ pairs anastomose, 1 pair passing to sides of short sinus-membrane; lower surface of midrib covered with pale erect hairs almost 1 mm long, similar hairs sparse on main veins, short erect hairs between veins; upper surface glabrous apart from midrib; sori all medial, not elongate, exindusiate; sporangia bearing several setae nearly as long as the body; spores with many small wings. *Pinnae* of type c. 1 mm long, 2 mm wide; of plants cultivated at Kew to 5×3 mm; veins free; sori present on largest pinnae.

Distr. *Malesia*: N.E. New Guinea (Sepik and Madang Districts, 3 collections).

Ecol. On shaded river bank (type) and sandstone walls of river gorge, at 30–200 m.

**12. *Pronephrium bulusanicum* (HOLT-TUM) HOLT-TUM**, *comb. nov.* — *Haplodictyum bulusanicum* HOLT-TUM, *Kalikasan* 2 (1973) 61. — Type: ELMER 16585, Mt Bulusan, Luzon (K; BO, FI, G, L.).

*Stipe* of sterile frond 5–6 cm, of fertile 9–14 cm long. *Lamina* to 12 cm long, 2.2–3.0 cm wide, short-acuminate, at the middle lobed 2/5 towards midrib, more deeply lobed at the base which is not narrowed, the basal lobes almost or quite free; veins in lobes near apex of frond 7–8 pairs, not forked, 1½–2 pairs anastomosing, next pair to sides of sinus-membrane; veins in lower lobes forked, forming areoles on each side of costule and additional irregular ones on each side of sinus-membrane and below it; veins and costules prominent on both surfaces; on lower surface of midrib stiff pale hairs 1 mm long and shorter ones abundant, shorter hairs present on costules and veins, yellow glands and fine erect hairs between veins; upper surface covered with short appressed hairs, longer ones also on midrib and costules. *Pinnae* 0.9–1.5×0.5–0.8 cm, crenate, narrowed towards base on basiscopic side. *Sori* inframedial; indusia rather large, bearing a variable number of short hairs and a few glands; sporangia glandular; spores with a wing and cross-wings.

Distr. *Malesia*: Philippines (Luzon, Sorsogon Province, 2 collections from type locality, 1 from Mt Pulog).

**13. *Pronephrium heterophyllum* (PRESL) HOLT-TUM**, *comb. nov.* — *Haplodictyum heterophyllum* PRESL, *Epim. Bot.* (1851) 51; FÉE, *Gen. Fil.* (1852) 309, t. 18C, f. 2; COPEL. *Fern Fl. Philip.* (1960) 378; HOLT-TUM, *Kalikasan* 2 (1973) 62. — *Aspidium heterophyllum* (PRESL) HOOK. *IC. Pl.* 10 (1854) t. 920; COPEL. *Polypod. Philip.* (1905) 39. — *Pleocnemia heterophylla* (PRESL) v.A.v.R. *Handb.* (1908) 171. — Type: CUMING 322, Samar (PRC; B, E, K, P).

*Aspidium blumei* KUNZE ex METT. Fil. Hort. Lips. (1856) 94, t. 22, f. 5. — *Aspidium blumei* var. *subpinnata* METT. Farnatt. IV (1858) 98, excl. syn. *Polypodium canescens* BL. et CUMING 251. — Type: CUMING 322 (formerly at LZ, now lost).

*Aspidium canescens* (BL.) CHRIST var.; CHRIST, Farnkr. der Erde (1897) 244. — *Dryopteris canescens* (BL.) C. CHR. var.; C. CHR. Ind. Fil. (1905) 256. — Fig. 14c-d.

*Caudex* short-creeping; fronds dimorphous. *Sterile fronds*. Stipe 1–3 cm long, with spreading pale hairs 1 mm long; fronds consisting of terminal lamina and 1–3 pairs of pinnae. *Terminal lamina* to 17×2.8 cm, apex rather abruptly pointed, base somewhat narrowed, middle part lobed not quite half-way to midrib, main veins 5–6 mm apart, veins in lobes 6–7 pairs, forked and anastomosing as in lower part of lamina of *P. bulusanicum*; base of lamina more deeply lobed, with transition to 2–3 pairs of pinnae close below it; hairs and glands as in *P. bulusanicum*. *Fertile fronds*. Stipe to 7 cm long; *terminal lamina* 13×1.6 cm, acuminate, lobed less deeply than sterile, veins closer and fewer than in sterile; *pinnae* 2 pairs, rather irregularly spaced, lowest 3–4 mm long; *sori* in terminal lamina medial or inframedial on the veins, not elongate; indusia with short hairs; sporangia usually with 1 gland; spores with translucent wing and cross-wings.

Distr. *Malesia*: Philippines (Samar, Southern Luzon, Mindanao).

Ecol. On rocks in stream-beds at 200–350 m (M. G. PRICE).

**14. *Pronephrium bakeri* (HARR.) HOLTUM**, *comb. nov.* — *Nephrodium bakeri* HARR. J. Linn. Soc. Bot. 16 (1877) 29; BAK. in Hook. Ic. Pl. 17 (1886) t. 1664. — *Dryopteris bakeri* (HARR.)

COPEL. Philip. J. Sci. 2 (1907) Bot. 405; v.A.v.R. Handb. (1908) 208. — *Haplodictyum bakeri* (HARR.) CHING, Sunyatsenia 5 (1940) 251; HOLTUM, Kalikasan 2 (1973) 63. — *Cyclosorus bakeri* (HARR.) COPEL. Gen. Fil. (1947) 142; Fern Fl. Philip. (1960) 358. — *Thelypteris bakeri* (HARR.) REED, Phytologia 17 (1968) 262. — Type: STEERE, Panay (MICH, K).

*Aspidium canescens* (BL.) CHRIST var. *sensu* CHRIST, Farnkr. der Erde (1897) 244. — *Dryopteris canescens* (BL.) C. CHR. var. *sensu* C. CHR. Ind. Fil. (1905) 256.

*Caudex* short-creeping. *Stipe* of sterile frond 5 cm, of fertile to 11 cm long; *fronds* consisting of terminal lamina and 1 pair (rarely 2 pairs) of pinnae; *terminal lamina* to 13×2.1 cm, apex abruptly short-pointed, middle part lobed 1/3 towards midrib, somewhat narrowed towards base which is sometimes dilated; main veins to 5 mm apart, veins to 7 pairs, not forked except sometimes in basal lobes of largest fronds; *lower surface* with pubescence and glands as in *P. bulusanicum*; *pinnae* opposite or not, to 10×7 mm, apex rounded, veins anastomosing. *Sori* medial on veins of terminal lamina, sometimes also on pinnae, not elongate; indusia hairy; sporangia sometimes with a gland; spores with a wing and cross-wings.

Distr. *Malesia*: Philippines (Luzon; Panay; Negros Oriental; Mindanao, cf. COPELAND, not seen).

Ecol. In forest at 500–800 m, near river (M. G. PRICE).

Notes. CLEMENS 16530, from Isabella Prov., Luzon, has dimorphic fronds; sterile fronds have an apical lamina to 2.5 cm wide, fertile to 1.4 cm. Some fronds also have a pair of very small pinnae some distance below the normal ones.

## 2. Section *Dimorphopteris*

(TAGAWA & K. IWATS.) HOLTUM, *Blumea* 19 (1971) 36; *Blumea* 20 (1972) 113–121. — *Dimorphopteris* TAGAWA & K. IWATS. Acta Phytotax. Geobot. 19 (1961) 8. — *Thelypteris* subg. *Dimorphopteris* K. IWATS. Mem. Coll. Sci. Univ. Kyoto B, 31 (1964) 35.

Type species: *Pronephrium moniliforme* (TAGAWA & K. IWATS.) HOLTUM.

Plants of moderate size, always with a relatively short deltoid apical lamina on fronds of adult plants, young plants rarely (as in *P. menisciicarpon*) having simple fronds 10 cm or more long; sterile and fertile fronds often dimorphous, the latter with longer stipes and smaller pinnae than the former; pinnae in most cases distinctly auricled on the acroscopic base.

Distr. 45 species, all Malesian (*P. beccarianum* extending to Fiji) except *P. articulatum* (HOULST. & MOORE) HOLTUM in Ceylon, India to S. China, and *P. palauense* (HOSOKAWA) HOLTUM in Palau island.

Notes. I suggest that a probable prototype for this section is shown by the Indian species *P.*



*articulatum* (see HOLTUM 1972: 116); the Malesian *P. glandulosum* differs from it in smaller size and greater abundance of glands. The other species are mostly still smaller, with a pronounced tendency to dimorphism, the most extremely dimorphic being the type species *P. moniliforme*.

This section agrees with *Sphaerostephanos* in the presence of spherical yellow glands, on either the lower surface of pinnae or on indusia or sporangia, in a majority of species; it differs from *Sphaerostephanos* in the absence of much-reduced basal pinnae and (in most species) in the pustular nature of the lower surface of dried fronds. But there appears to be an evolutionary trend within *Sphaerostephanos* towards reduction in the number of such small basal pinnae, and there are species in which some fronds may have 1–2 pairs of reduced pinnae and others none, on the same plant. I see no sharp distinction between such species and others which have no reduced basal pinnae. Thus on this character there appears to be no clear separation of this section from *Sphaerostephanos*. The section does however give the impression of being natural if one excludes from it species with deeply lobed non-pustular normal pinnae (e.g. *Nephrodium diversilobum* PRESL); such species are here placed in *Sphaerostephanos* (in some cases they have obvious relatives in that genus). Even when this is done, the present section may still include species of two different ancestral origins: those derived from ancestors with, and without, reduced basal pinnae. The whole problem of recognizing affinities is complex; the present arrangement is one of convenience pending further investigation of an experimental nature.

The present arrangement includes some species placed in *sect. Pronephrium* in 1972; *P. buwaldae* HOLTUM, included here in 1972, is now transferred to *Christella*.

# KEY TO THE SPECIES

1. Sori exindusiate.
  2. Pinnae not more than 3 cm long.
    3. Upper surface short-appressed-hairy; sori elongate . . . . . 15. *P. millarae*
    3. Upper surface glabrous; sori not elongate . . . . . 16. *P. peramelense*
  2. Pinnae longer on mature plants.
    4. Fertile pinnae 2 mm wide . . . . . 17. *P. moniliforme*
    4. Fertile pinnae to at least 1 cm wide.
      5. Surfaces between veins glabrous.
        6. Sporangia setiferous . . . . . 18. *P. amboinense*
        6. Sporangia not setiferous.
          7. Pinnae 2–3 cm wide . . . . . 19. *P. firmulum*
          7. Pinnae not over 1 cm wide . . . . . 20. *P. aquatiloides*
        5. Surfaces both short-hairy between veins.
          8. Pinnae c. 15 pairs . . . . . 21. *P. simillimum*
          8. Pinnae 2–3 pairs . . . . . 22. *P. giluwense*
  1. Sori indusiate.
    9. Fronds simple, 10–20 cm long with cordate base . . . . . 37. *P. menisciicarpon*
    9. Fronds pinnate or, if simple, smaller and sterile.
      10. Lower surface between and/or on veins bearing sessile spherical glands.
        11. Veins free . . . . . 23. *P. kjellbergii*
        11. Veins anastomosing.
          12. Free pinnae not over 7 pairs, not over 2.0 cm wide.
            13. Hairs on lower surface of costules and on upper surface between veins not appressed . . . . . 24. *P. amphitrichum*
            13. Hairs on lower surface of costules and on upper surface appressed.
              14. Indusium bearing glands . . . . . 25. *P. clemensiae*
              14. Indusium bearing hairs . . . . . 25b. *P. clemensiae* var. *degenerum*
          12. Free pinnae more numerous or wider.
            15. Lower pinnae with stalks 1–2 mm long . . . . . 26. *P. glandulosum*
            15. Lower pinnae sessile.
              16. Hairs on lower surface of costae and costules erect . . . . . 27. *P. debile*
              16. Hairs on lower surface of costae and costules slender, appressed.
                17. Sterile and fertile pinnae both 8–9 cm long . . . . . 25b. *P. clemensiae* var. *degenerum*
                17. Sterile and fertile pinnae dimorphous, smaller.
                  18. Sterile pinnae c. 4.5 × 1.4 cm; rachis almost glabrous on abaxial surface . . . . . 28. *P. minahassae*
                  18. Sterile pinnae c. 2.0 × 0.8 cm; rachis bearing copious erect hairs on abaxial surface . . . . . 29. *P. solsonicum*
        10. Lower surface between and on veins lacking sessile spherical glands.
          19. Glands present on sporangia, in some cases setae also.

20. Fertile pinnae 3–4 mm wide; sterile to 10 mm wide . . . . . 30. *P. celebicum*  
 20. Fertile pinnae 10 mm or more wide; little dimorphism.  
 21. Pinnae 6–10 pairs; sporangia bearing small glands only.  
 22. Pinnae 2–3 cm wide . . . . . 19. *P. firmulum*  
 22. Pinnae not over 1 cm wide . . . . . 20. *P. aquatiloides*  
 21. Pinnae 3–4 pairs; sporangia often with both glands and setae . . . . . 31. *P. granulosum*  
 19. Sporangia lacking glands; setae present in most cases.  
 23. Fertile pinnae less than 1.5 cm long; sori in 1 row on each side of costa . . . . . 32. *P. samarense*  
 23. Fertile pinnae to at least 2 cm long; sori in several rows.  
 24. Pinnae and/or frond-apex on both young and adult plants  $\pm$  dilated and irregularly lobed distally . . . . . 33. *P.  $\times$  xiphioides*  
 24. Pinnae not thus dilated nor irregularly lobed.  
 25. Basal pinnae narrowly cuneate at base both sides, not auricled; fertile pinnae not or little narrower than sterile. . . . . 18. *P. amboinense*  
 25. Basal pinnae otherwise, usually auricled; fertile pinnae in most cases narrower than sterile.  
 26. Indusia not very small, bearing many short hairs.  
 27. Upper surface of pinnae bearing short suberect hairs between veins.  
 28. Pinnae 7 pairs; indusia thin with some superficial hairs . . . . . 34. *P. trachyphyllum*  
 28. Pinnae 15 pairs; indusia firm with stiff marginal hairs . . . . . 35. *P. thysanoides*  
 27. Upper surface glabrous between veins.  
 29. Sporangia setiferous.  
 30. Sterile pinnae barely 1 cm wide . . . . . 36. *P. hosei*  
 30. Sterile pinnae commonly 2 cm or more wide.  
 31. Sterile pinnae entire, to  $13 \times 4$  cm . . . . . 37. *P. menisciocarpon*  
 31. Sterile pinnae crenate, to  $11 \times 2.5$  cm . . . . . 31. *P. granulosum*  
 29. Sporangia lacking setae.  
 32. Indusia firm, almost circular, with hairs in the middle . . . . . 38. *P. hewittii*  
 32. Indusia thin, shrivelled when dry, hairy throughout.  
 33. Sterile pinnae crenate, at least distally . . . . . 39. *P. affine*  
 33. Sterile pinnae entire . . . . . 37. *P. menisciocarpon*  
 26. Indusia small, with dark red cell-walls; marginal hairs few or none.  
 34. Fertile pinnae 1.5 cm or more wide . . . . . 40. *P. borneense*  
 34. Fertile pinnae not more than 1 cm wide.  
 35. Sterile pinnae not or little more than 1 cm wide, fertile 3–6 mm wide.  
 36. Pinnae thick; lower surface glabrous with thick pale prominent veins . . . . . 41. *P. exsculptum*  
 36. Pinnae thin; hairs present on lower surface of costae; veins concolorous, not prominent.  
 37. Pinnae to 15 pairs, sterile ones 4–6 cm long, narrowly acuminate . . . . . 42. *P. merrillii*  
 37. Pinnae not over 10 pairs, sterile ones shorter, abruptly pointed . . . . . 43. *P. rhombeum*  
 35. Sterile pinnae 1.5 cm or more wide, fertile 5–10 mm wide . . . . . 44. *P. peltatum*

**15. *Pronephrium millarae* HOLTUM**, Blumea 20 (1972) 115. — Type: WOMERSLEY & MILLAR NGF 8500, N.E. New Guinea, Morobe Distr., Wau-Salamaua Road 1600 m (LAE).

*Caudex* short-creeping; fronds dimorphous. *Sterile fronds*. *Stipe* 7–8 cm long, covered densely with hairs 0.1–0.2 mm long. *Lamina* 14 cm long; pinnae 7–8 pairs, all with stalks 1–1.5 mm long; basal pinnae slightly reduced and deflexed, basiscopic base rounded, acroscopic truncate and slightly auricled. *Largest pinnae* 2.5–3.5  $\times$  1 cm; base subtruncate, apex rounded to bluntly pointed, edges slightly crenate near base, more distinctly so distally; costules 2.5–3.5 mm apart, at little more than 45° to costa; veins slender and slightly prominent beneath, 3–4 pairs, 1½ pairs anastomosing, sinus-membrane not distinct; *lower surface* of rachis and costa bearing stiff erect hairs 0.2–0.4 mm long, hairs on costules and veins shorter and somewhat antrorse, on surface be-

tween veins many appressed hairs 0.1–0.2 mm long, no glands; *upper surface* throughout bearing stiff suberect hairs 0.2–0.3 mm long. *Fertile fronds*. *Pinnae* 2.0–2.3 cm long, 0.8 cm wide, lower ones rather widely spaced, shape and pubescence as sterile; *sori* exindusiate, occupying whole of basal veins and sometimes the base of an excurrent vein, on middle part of distal veins; sporangia sometimes with a gland, not setiferous.

*Distr. Malesia*: Eastern New Guinea, Goodenough Island.

*Ecol.* On Goodenough Island “common in a moist gully” (BRASS 24636).

**16. *Pronephrium peramelense* HOLTUM**, Blumea 20 (1972) 115. — Type: PULLE 415, Western New Guinea, *Perameles bivouac*, 1000 m (BM; L).

*Caudex* horizontal, 2–2.5 mm diameter, bearing stipes 5 mm or more apart; fronds not dimorphous. *Stipe* 10–20 cm long, dark, short-hairy;

basal scales 3–4 mm long, narrow, rather firm with few hairs. *Lamina* to 15 cm long; apex broadly triangular, pinnae to 8 pairs, basal ones a little deflexed with somewhat asymmetric and sometimes slightly auricled base. *Middle pinnae* to  $3.0 \times 1.3$  cm; base truncate, apex rather abruptly narrowed to a rounded tip, edges irregularly slightly crenate to subentire; costules to 4 mm apart; veins 2 pairs,  $1-1\frac{1}{2}$  pairs anastomosing; sinus-membrane not evident; lower surface of rachis covered with dense spreading dark rigid curved hairs 0.3 mm long, rest glabrous; upper surface of costa hairy near base only, rest of surface glabrous. *Sori* inframedial, on all veins, not elongate, exindusiate; sporangia without glands or setae.

Distr. *Malesia*: Western New Guinea; only known from the type.

**17. *Pronephrium moniliforme*** (TAGAWA & K. IWATS.) HOLTUM, *Blumea* 20 (1972) 115. — *Dimorphopteris moniliformis* TAGAWA & K. IWATS. *Acta Phytotax. Geobot.* 19 (1961) 8, f. 14–16. — *Thelypteris moniliformis* (TAGAWA & K. IWATS.) K. IWATS. *Mem. Coll. Sci. Univ. Kyoto B*, 31 (1964) 36. — Type: HARADA s.n. 30 June 1944, Halmahera (KYO).

*Caudex* short-creeping, 3–3.5 mm diameter; fronds dimorphous. *Sterile fronds*. *Stipe* 7–10 cm long, pale, minutely hairy; *lamina* 15–20 cm long; pinnae c. 15 pairs; basal pinnae deflexed, not reduced; *middle pinnae*  $4 \times 1$  cm, base truncate with acroscopic auricle, apex acute, edges serrulate; costules 2.5 mm apart; veins 4–5 pairs, 2 pairs anastomosing; lower surface minutely hairy. *Fertile frond*. *Stipe* 20–24 cm long; *lamina* 20–24 cm long; pinnae more than 20 pairs, 4 cm long, 2 mm wide, entirely covered beneath with sporangia (which spread to the surface between veins); veins forming a single row of narrow areoles with a short free vein in each crenature of margin; sporangia bearing glands; spores with longitudinal wing and cross-wings.

Distr. *Malesia*: Moluccas (Halmahera; Batjan: ALSTON 16908, BM).

**18. *Pronephrium amboinense*** (WILLD.) HOLTUM, *Blumea* 20 (1972) 120. — *Aspidium amboinense* WILLD. *Sp. Pl. ed. 4*, 5 (1810) 228. — *Thelypteris amboinensis* (WILLD.) REED, *Phytologia* 17 (1968) 259. — Type: VENTENAT, Ambina (B, Herb. Vind. 19751).

*Aspidium canescens forma nephrodiiformis* CHRIST, *Ann. Jard. Bot. Btzg* 15 (1898) 131, *quoad* SARASIN 975, Celebes, Palopo (BAS).

*Dryopteris subconformis* C. CHR. *Bot. Jahrb.* 66 (1933) 47. — Syntypes: KJELLBERG 1999, Celebes, Lamasie, Palopo (BO); KJELLBERG 1360, S.E. Celebes, Labibia (BO).

*Pronephrium palopense* HOLTUM, *Blumea* 20 (1972) 116. — Type: KJELLBERG 1999, Celebes (BO). — Fig. 15a.

*Caudex* short, suberect; fronds slightly dimorphous. *Stipe* 20–40 cm long (longest on fertile fronds), minutely hairy; *lamina* c. 20 cm long, apex acuminate, deeply lobed with gradual transition to pinnae; free pinnae 10–15 pairs, basal pair not reduced, narrowed to base both sides. *Middle pinnae* c.  $5.0 \times 1.3$  cm (sterile), to  $6.0 \times 1.1$  cm (fertile); base truncate and slightly auricled on acroscopic side, apex short-acuminate (more abruptly pointed on pinnae of smaller fronds), edges crenate to a depth of 1–2 mm; costules to 3 mm apart; veins 4–5 pairs,  $1-1\frac{1}{2}$  pairs anastomosing,  $\frac{1}{2}$ –1 pairs to sides of short sinus-membrane; lower surface of rachis, costae and costules bearing rather sparse minute hairs, surface between veins slightly pustular; hairs on upper surface of costae less than 0.5 mm, sparse and shorter hairs on costules, a few minute hairs sometimes between veins near margin. *Sori* medial; indusia small, short-hairy (in some cases absent?); sporangia with several setae; spores pale with translucent wing and a few cross-wings.

Distr. *Malesia*: S.E. & Central Celebes, Moluccas (Amboina).

Ecol. At low altitudes, in forest, on stream-bank (KJELLBERG 1360).

Notes. Four collections known. The type from Amboina is a small frond (pinnae to  $3.0 \times 0.8$  cm) of which the sori are in poor condition; a few sporangia are certainly setiferous but no indusia are present. SARASIN 975 from Palopo agrees closely with the type in shape of frond and pinnae (to  $4.5 \times 1.2$  cm) and certainly has small indusia. One of KJELLBERG's specimens on which CHRISTENSEN based *Dryopteris subconformis* (n. 1999), also from Palopo, is somewhat larger than SARASIN's and apparently lacks indusia; KJELLBERG's second specimen (n. 1360) from S.E. Celebes has indusia. In 1972 I confusedly cited KJELLBERG 1999 both as type of *D. subconformis* and of *Pronephrium palopensis*; I had intended to cite 1360 as type of the former.

BLUME misinterpreted *Aspidium amboinense* WILLD. and described under that name small specimens of *Christella subpubescens* which had many club-shaped glands on them. This error was copied by later authors and all subsequent citations of WILLDENOW's species are erroneous.

**19. *Pronephrium firmulum*** (BAK.) HOLTUM, *Blumea* 20 (1972) 116. — *Polypodium firmulum* BAK. *Kew Bull.* (1893) 211. — *Dryopteris firmula* (BAK.) C. CHR. *Ind. Fil.* (1905) 266; *Gard. Bull. Str. Sett.* 7 (1934) 249. — *Phegopteris firmula* (BAK.) v. A. v. R. *Handb.* (1908) 501. — Type: C. HOSE 295, Sarawak, Mt Dulit (K).

*Caudex* long-creeping, 3–5 mm diameter, bearing fronds 1–1.5 cm apart; fronds not or little dimorphous. *Stipe* to 45 cm long, glabrous; *lamina* to 35 cm long, apical section subentire with widened base, small on largest fronds, pinnae to

12 pairs, of firm texture; basal pinnae narrowed both sides towards the base, acroscopic base sometimes with a slight auricle. *Middle pinnae* from Mt Dulit to  $11 \times 2.5$  cm, from Mt Kinabalu to  $15 \times 3.3$  cm, base subtruncate and distinctly auricled (more on fertile than sterile pinnae), apex acuminate, edges irregularly slightly sinuous; costules  $3.5\text{--}4.5$  mm apart, at less than  $60^\circ$ ; veins  $5\text{--}7$  pairs, prominent on both surfaces, almost all anastomosing with continuous zig-zag excurrent veins; *lower surface* of rachis covered with thick curved hairs barely  $0.5$  mm long, costae of Dulit specimens bearing sparse short antrorse (not appressed) hairs, many such hairs on Kinabalu specimens, rest glabrous, surface between veins pustular; *upper surface* of rachis as lower, of costae bearing rather sparse hairs less than  $0.5$  mm long, no others. *Sori* somewhat inframedial; indusia none or very small, glabrous; sporangia many, with rather small red or yellow glands, no setae; spores not seen.

Distr. *Malesia*: Borneo (Sarawak; Sabah).

Ecol. On rocks by streams in forest at  $250\text{--}1000$  m.

Note: Kinabalu specimens have broader and somewhat thinner pinnae than those from Dulit; indusia have only been seen on some sori of the former.

**20. *Pronephrium aquatiloides* (COPEL.) HOLT-TUM**, *Blumea* 20 (1972) 108. — *Dryopteris aquatiloides* COPEL. Philip. J. Sci. 7 (1912) Bot. 59; v.A.v.R. Handb. Suppl. (1917) 177. — *Thelypteris aquatiloides* (COPEL.) REED, *Phytologia* 17 (1968) 260. — Type: BROOKS 9, Sarawak, Bongo Range (MICH; BM, L).

*Cyclosorus jacobsii* HOLTUM, *Blumea* 11 (1962) 530. — *Thelypteris jacobsii* (HOLTUM) REED, *Phytologia* 17 (1968) 285. — Type: JACOBS 5086, Sarawak, Mt Penrissen (L; K).

*Caudex* long-creeping,  $2\text{--}3$  mm diameter; fronds c.  $5$  mm apart. *Stipe*  $15\text{--}30$  cm long, minutely hairy; *lamina* to  $27$  cm long, apex pinna-like, pinnae  $6\text{--}8$  pairs; basal pinnae narrowed towards base both sides, with stalks to  $4$  mm long. *Middle pinnae*  $9\text{--}11 \times 1.0$  cm; base auricled on acroscopic side; apex acuminate with rounded tip  $2$  mm wide; edges almost entire; costules  $3$  mm apart; veins  $3\text{--}4$  pairs, anastomosing to form a zig-zag excurrent vein, slightly prominent; hairs on *lower surface* of rachis thick, brown, curved,  $0.5$  mm long, on costae same length, slender, antrorsely appressed, no others hairs; surface between veins pustular; *upper surface* of rachis hairy as lower, costal hairs shorter, no others hairs. *Sori* medial, basal ones sometimes coalescent; indusia very small, glabrous or glandular; sporangia bearing red glands; spores not seen.

Distr. *Malesia*: Borneo (W. Sarawak).

Ecol. On rocks by streams in forest at  $300\text{--}1000$  m.

**21. *Pronephrium simillimum* (C. CHR.) HOLT-TUM**, *Blumea* 20 (1972) 116. — *Dryopteris simillima* C. CHR. Ind. Fil. (1905) 292, new name for *Nephrodium simulans* BAK. J. Bot. 26 (1888) 325, non BAK. 1874; v.A.v.R. Handb. (1908) 223. — *Thelypteris simillima* (C. CHR.) K. IWATS. Acta Phytotax. Geobot. 21 (1965) 169. — Type: G. F. HOSE 231, Sarawak, limestone hills (K).

*Caudex* short-creeping to suberect; fronds hardly dimorphous. *Stipe*  $12\text{--}25(45)$  cm long, minutely hairy, basal scales dark, narrow, rigid, to  $8$  mm long with stiff pale hairs  $0.2$  mm long; *lamina* very firm,  $25\text{--}40$  cm long, apex deltoid and deeply lobed; pinnae  $12\text{--}16$  pairs; basal pinnae slightly reduced, narrowed to base on basicopic side. *Largest pinnae* of type  $4.7 \times 1.6$  cm (width above base), largest seen  $6.0 \times 1.7$  cm; base truncate and distinctly auricled on acroscopic side; apex abruptly narrowed, rounded or broadly pointed; edges lobed to depth of  $1.5\text{--}2$  mm (on young plants almost entire), lobes oblique, rounded, more or less distinctly dentate at ends of veins; costules to  $4$  mm apart, at c.  $50^\circ$  to costa; veins  $5\text{--}6$  pairs, slightly prominent both sides,  $1\frac{1}{2}\text{--}2$  pairs anastomosing, 1 pair to sides of sinus-membrane; *lower surface* of rachis covered with stiffly erect pale hairs  $0.2\text{--}0.4$  mm long, similar hairs  $0.1\text{--}0.2$  mm long on costae, costules, veins and on surface between veins; *upper surface* similarly hairy, hairs between veins more dense than on lower surface. *Sori* small, medial, exindusiate; sporangia with  $6\text{--}8$  slender setae; spores with rather broad finely erose translucent wing and cross-wings.

Distr. *Malesia*: Borneo; S.W. Celebes (BROOKS 16853, Maros).

Ecol. On limestone,  $0\text{--}1700$  m.

Notes. One specimen from a shaded place at entrance to a cave has thinner pinnae more deeply lobed than above described, to  $2.2$  cm wide, costules  $5$  mm apart, pinna-lobes distinctly dentate at all vein-ends, veins often forked, only 1 pair anastomosing. A specimen from  $1700$  m on G. Mulu is small, with 5 pairs of free pinnae, largest  $3.0 \times 1.3$  cm, hairs on lower surface of rachis and costae more than  $0.5$  mm long.

**22. *Pronephrium giluwense* HOLTUM, sp. nov.**

*Pinnae paucijugatae, inferiores leviter redactae auriculatae stipitataeque, pinnae majores 5 cm longae, 1.5 cm latae, vix dimorphae; pagina inter venas utraque pilis brevibus vestita; sori exindusiati, sporangia setis 3–6 praedita.* — Type: WOODHAMS 138, Papua, Mt Giluwe,  $2400$  m, cult. Hort. Kew. (K).

*Caudex* short-creeping; *stipe* to  $14$  cm long, short-hairy; *lamina* thin, to  $16$  cm long consisting of apical section  $7 \times 2.4$  cm lobed as pinnae and 3 pairs of pinnae; basal pinnae  $2.5 \times 1.4$  cm, rather strongly auricled, with stalks  $1.5$  mm long. *Largest pinnae*  $5.0 \times 1.5$  cm with stalks  $1$  mm; base broadly

cuneate and slightly auricled on acroscopic side, apex abruptly short-acuminate; edges lobed 1/3 towards costa; costules 4 mm apart at 45° to costa; veins slender, slightly prominent, 5–6 pairs, 1 pair anastomosing, 1–1½ pairs to sides of sinus-membrane; lower surface of rachis and costae bearing spreading hairs of varied length to 0.8 mm, shorter slender hairs on costules, veins and surface between them; upper surface covered with suberect hairs 0.2–0.3 mm long, longer hairs present on costae and scattered on costules and veins. *Sori* medial, lowest supramedial, exindusiate; sporangia bearing 3–6 rather long setae; spores with a longitudinal wing and cross-wings.

Distr. *Malesia*: Papua New Guinea. The only other collection is CLEMENS 12110 D, from a branch of the Buso River, Morobe District, at 1500–1800 m (MICH); this is a less mature plant with longer apical lamina than the type; it differs also in having a few glands on the lower surface of pinnae.

Note. The type plant perhaps did not attain its full size before dying. Possibly this species should be transferred to *Sphaerostephanos* but it does not match any known species in that genus.

**23. *Pronephrium kjellbergii* HOLTUM**, *Blumea* 20 (1972) 117. — KJELLBERG 2638, Central Celebes, Mt Porema 1400 m (BO).

*Caudex* short-creeping; fronds subdimorphous. *Stipe* of sterile frond 3–4 cm long, of fertile 10 cm, short-hairy, basal scales 4 × 1 mm bearing short hairs; *lamina* 8 cm long, thin; pinnae 7 pairs, lower sterile ones sometimes a little reduced, fertile not; apical lamina deltoid and deeply lobed. *Largest pinnae* 1.5 × 0.6 cm (sterile) 1.0 × 0.6 cm (fertile); base truncate and a little dilated on acroscopic side; apex blunt; edges crenate; costules 2.5 mm apart; veins 2 pairs (sometimes 3 pairs in basal acroscopic lobe), all free; lower surface of rachis, costae and costules bearing sparse hairs 0.5 mm long, many glands on and between veins; upper surface throughout bearing short antrorse hairs with longer ones scattered on costules and veins. *Sori* near bases of veins; indusia bearing a few hairs and glands; sporangia sometimes with a gland.

Distr. *Malesia*: Central Celebes, 1400 m. Only known from the type.

Note. This specimen was named *Dryopteris urdanetensis* COPEL. by CHRISTENSEN (Bot. Jahrb. 66, 1933, 48) but differs from that species in having a much shorter apical lamina and no much-reduced basal pinnae.

**24. *Pronephrium amphitrichum* HOLTUM, sp. nov.**

*P. clemensiae* (Copel.) Holtum affinis, differt: *pinnis multo minoribus; pilis costarum costularumque subtus patentibus, pilis inter venas paginae superioris non appressis; soris venarum*

*inferiorum elongatis*. — Type: EDANO BS 75790, Luzon, Camarines Sur, Mt Potianay (MICH; NY).

*Caudex* suberect; fronds subdimorphous. *Stipe* 3 cm long (sterile) 6–7 cm (fertile), short-hairy, basal scales 3 mm long, narrow; *lamina* 5 cm long; pinnae 4–5 pairs; basal pinnae slightly reduced, much narrowed towards base on basisopic side. *Largest pinnae* to 1.8 × 0.9 cm (sterile) 1.5 × 0.8 cm (fertile); base truncate and slightly auricled on acroscopic side, narrowed and rounded on basisopic; apex abruptly blunt-pointed; edges crenate to depth of 1 mm; costules to 3 mm apart at little over 45° to costa; veins 3 pairs, 1 pair anastomosing; lower surface of rachis bearing thick pale spreading hairs 0.5 mm long, hairs on costae and costules similar but shorter, abundant slender erect hairs and a few glands on surface between veins; hairs on upper surface of rachis thick, curved, to 1 mm long, on costae 0.2–0.3 mm, on costules and veins scattered longer hairs, between veins copious suberect hairs 0.2 mm long. *Sori* inframedial to medial, lower ones elongate; indusium small with short stiff hairs; sporangia sometimes with a gland.

Distr. *Malesia*: Philippines (Luzon). Only known from the type.

**25. *Pronephrium clemensiae* (COPEL.) HOLTUM**, *Blumea* 20 (1972) 118. — *Dryopteris clemensiae* COPEL. *Philip. J. Sci.* 46 (1931) 213. — *Cyclosorus clemensiae* (COPEL.) CHING, *Bull. Fan Mem. Inst. Biol. Bot.* 10 (1941) 243; COPEL. *Fern Fl. Philip.* (1960) 369. — *Thelypteris clemensiae* (COPEL.) REED, *Phytologia* 17 (1968) 268. — Type: CLEMENS 16490, Luzon, Isabella Prov., Mt Moises (UC; US).

#### **a. var. *clemensiae***

*Caudex* short-creeping; fronds subdimorphous. *Stipe* 8–10 cm long (sterile), 16 cm (fertile), hairy as rachis distally, basal scales to 3 × 1 mm, firm; *lamina* 13 cm long, texture firm, apex broadly triangular and deeply lobed, pinnae 5 pairs, basal pinnae not reduced, narrowed towards base of basisopic side. *Largest pinnae* 4.3 × 1.8 cm (sterile) 3.2 × 1.5 cm (fertile); base subequally broadly cuneate; apex abruptly narrowed to acute tip; edges lobed to depth of 2 mm; costules 3.5–4 mm apart, at 45° to costa; veins 4–5 pairs, prominent both sides, 1–1½ pairs anastomosing; lower surface of rachis covered with coarse erect hairs, hairs on costae and costules shorter and antrorsely appressed, glands abundant on lower surface generally; hairs on upper surface of costae, costules and veins antrorse as lower surface, between veins rather sparse appressed hairs. *Sori* medial; indusia rigid, dark, with yellow glands and sometimes a few hairs; sporangia often with a yellow gland.

Distr. *Malesia*: Philippines (Luzon); only known from the type.

b. *var. degenerum* (CHRIST) HOLTUM, *comb. nov.* — *Dryopteris canescens* *var. degenera* CHRIST, Philip. J. Sci. 2 (1907) Bot. 199. — *Phegopteris canescens* *var. degenera* (CHRIST) v.A.v.R. Handb. (1908) 507. — *Cyclosorus degener* (CHRIST) COPEL. Fern Fl. Philip. (1960) 356. — *Thelypteris degenera* (CHRIST) REED, Phytologia 17 (1968) 271. — Lectotype (HOLTUM 1972): LOHER s.n. March 1906, Luzon, Montalban (P).

Differs from *var. clemensiae*: indusia densely setose; sporangia bearing glands or setae. Spores have a complete translucent wing.

Distr. *Malesia*: Philippines, Luzon (C. B. ROBINSON BS 9455, Tayabas Prov. Infanta; RAMOS BS 1791, Rizal Prov.; M. G. PRICE 2824, Zambales Prov., Mts above Palauig at 1000 m).

Notes. PRICE's specimen is much larger than the others (pinnae to  $8.5 \times 2.0$  cm) and has rather sparse glands on lower surface but agrees in other respects. I designate the LOHER collection from Montalban as lectotype because I did not find the other syntype, also collected by LOHER, at Paris.

26. *Pronephrium glandulosum* (BL.) HOLTUM, Blumea 20 (1972) 118. — *Aspidium glandulosum* BL. En. Pl. Jav. (1828) 144; METT. Fargatt. IV (1858) 111, *quoad descr. tantum*. — *Nephrodium glandulosum* (BL.) J. SM. in Hook. J. Bot. 3 (1841) 411, *nomen tantum*; PRESL, Epim. Bot. (1851) 45, *excl. pl. Zoll.*; HOOK. Spec. Fil. 4 (1862) 76, *excl. syn. omn. praeter BL.*; RACIB. Fl. Btztg 1 (1898) 185. — *Abacopteris glandulosa* (BL.) FÉE, Gen. Fil. (1852) 310. — *Dryopteris glandulosa* (BL.) O. KTZE, Rev. Gen. Pl. 2 (1891) 812; v.A.v.R. Handb. (1908) 215. — *Dryopteris malayensis* C. CHR. Dansk Vid. Selsk. Skr. VII, 10 (1913) 171, *nom. nov. illegit.*; BACKER & POSTH. Varenfl. Java (1939) 59. — *Cyclosorus glandulosus* (BL.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 8 (1938) 227; HOLTUM, Rev. Fl. Malaya 2 (1955) 278, f. 160. — *Thelypteris malayensis* (C. CHR.) REED, Phytologia 17 (1968) 291. — Type: BLUME s.n., W. Java (L. n. 908, 337–89).

*Dryopteris iridescens* v.A.v.R. Bull. Jard. Bot. Btztg II, 11 (1913) 11; Handb. Suppl. (1917) 176. — *Thelypteris iridescens* (v.A.v.R.) REED, Phytologia 17 (1968) 285. — Type: MATTHEW 517, Sumatra, Padang Panjang (BO).

*Dryopteris excrescens* COPEL. Univ. Cal. Publ. Bot. 14 (1929) 374. — Type: RAHMAT SI TOROES 142, Sumatra (C; L).

*Dryopteris bartlettii* COPEL. *ibid.* l.c. — *Thelypteris bartlettii* (COPEL.) REED, Phytologia 17 (1968) 263. — Type: BARTLETT 6692, Sumatra, Asahan (UC).

*Nephrodium lineatum* *sensu* BEDD. Handb. Suppl. (1892) 71, *excl. syn. Aspidium affine* BL.

*Caudex* short-creeping; fronds dimorphous. *Sterile fronds*. Stipe 20–30 cm long, minutely hairy; lamina 30–40 cm long; pinnae 12 pairs; basal pinnae narrowed at base, more on basiscopic

than acroscopic side, with stalks 2 mm long. *Largest pinnae* commonly to  $12 \times 2.5$  cm; base truncate, auricled on acroscopic side, apex abruptly short-acuminate; edges obliquely lobed to a depth of 1–2 mm or sometimes more deeply; costules to 5 mm apart; veins to 8 pairs, 2–4 pairs anastomosing (according to depth of lobing),  $1\frac{1}{2}$ –2 pairs to sides of sinus-membrane; lower surface of rachis covered with thick curved hairs more than 0.5 mm long, similar but shorter hairs on costae, very short and sparse on costules and veins, surface between veins pustular, bearing many glands and sometimes very short erect hairs; upper surface covered throughout more or less closely with fine appressed hairs 0.2–0.3 mm long. *Fertile fronds*. Stipe to 50 cm long; pinnae more widely spaced than sterile, commonly to  $7 \times 1.5$  cm, edges shallowly crenate; sori medial, lower ones at least somewhat elongate along veins; indusia thin bearing many very short hairs; sporangia with glands on body and a hair with glandular tip on stalk; spores with a complete wing and cross-wings.

Distr. *Malesia*: Java, Sumatra, Malaya.

Ecol. Lowland, up to 800 m, in forest near streams.

Notes. The lobing of pinnae is variable. One Java specimen at Kew (coll. LOBB) has both sterile and fertile pinnae almost entire. A specimen collected by KURZ on G. Salak (PR) has fertile pinnae  $7 \times 1.7$  cm, lobed fully half-way to costa.

The name *Aspidium glandulosum* BL. was variously misinterpreted by J. SMITH, KUNZE and HOOKER, who cited specimens of other species; these citations were copied by METTENIUS and PRESL who both gave good descriptions. Apart from the presence of copious glands on lower surface and appressed hairs on the upper, this species is very similar to *A. affine* BL., with which BEDDOME confused it under the name *Nephrodium lineatum*.

27. *Pronephrium debile* (BAK.) HOLTUM, Blumea 20 (1972) 118. — *Nephrodium debile* BAK. J. Bot. 18 (1880) 212. — *Dryopteris pseudoreptans* C. CHR. Ind. Fil. (1905) 286, *nom. nov.* (not *D. debilis* (METT.) C. CHR.); v.A.v.R. Handb. (1908) 223. — *Thelypteris pseudoreptans* (C. CHR.) REED, Phytologia 17 (1968) 306. — Type: BECCARI 433, Sumatra, G. Singgalang 1700 m (K).

*Nephrodium pilosiusculum* RACIB. Fl. Btztg 1 (1898) 189. — *Dryopteris pilosiuscula* (RACIB.) C. CHR. Ind. Fil. (1905) 284; v.A.v.R. Handb. (1908) 215; BACKER & POSTH. Varenfl. Java (1939) 65, *excl. syn. Aspidium pilosiusculum* METT. — *Thelypteris pilosiuscula* (RACIB.) REED, Phytologia 17 (1968) 304. — Type: RACIBORSKI, Java, G. Salak, Tjiapoos (BO; K, L, P).

*Caudex* short-creeping; fronds slightly dimorphous. Stipe 15–20 cm long, glabrous except base which is covered with minute hairs and firm setiferous scales  $2 \times 1$  mm; lamina 15–25 cm long,

firm in texture; apical lamina narrowly acuminate; pinnae 10–15 pairs; basal pinnae slightly narrowed at base on basiscopic side, sessile. *Largest pinnae*  $4.5 \times 1.5$  cm (sterile)  $3.0 \times 1.0$  cm (fertile); base truncate and slightly auricled; apex abruptly short-acuminate with rounded tip; edges crenate or in the largest sterile pinnae lobed to a depth of 2–3 mm; costules 3–4 mm apart; veins 3–4 pairs, 1 pair anastomosing, next pair to sides of sinus-membrane; lower surface of rachis covered with thick spreading brown hairs 0.7 mm or more long and shorter pale ones, hairs on costae and costules dense, pale, 0.4 mm long, somewhat antrorse, hairs on veins shorter with some yellow glands, surface between veins bearing many short erect hairs and a few glands (especially distal on the lobes); upper surface of rachis bearing erect thick brown hairs 1 mm long, pinnae covered closely with appressed hairs 0.5 mm long. *Sori* medial; indusia covered with short hairs, 1–2 glands also sometimes present; sporangia bearing glands.

Distr. *Malesia*: Sumatra, Java, Flores.

Ecol. On wet rocks by streams at 1400–1800 m.

Note. BECCARI's specimen from G. Singgalang has more deeply lobed pinnae than RACIBORSKI's from Tjiapoos but differs little in other respects. RACIBORSKI cited a specimen of ZIPPELIUS (to whom he attributed the name) as well as his own; I have not found the former and take RACIBORSKI's own, which he described, to be the type. Confusion has been caused because METTENIUS independently published the name *Aspidium pilosiusculum* ZIPP. as a new name for *Gymnogramme appendiculata* BL. (here transferred to *Sphaerostephanos*). Both species were collected by RACIBORSKI at Tjiapoos (Mt Salak, W. Java).

**28. *Pronephrium minahassae* HOLTUM**, Blumea 20 (1972) 119. — Type: ALSTON 16410, N. Celebes, G. Tetawiran (BM).

*Caudex* short, suberect; fronds dimorphous. *Sterile fronds*. Stipe to 15 cm long, minutely hairy, basal scales small. *Lamina* to 25 cm long, texture thin; apical lamina pinna-like, to 10 cm long; pinnae to 10 pairs, basal pair more remote and narrowed to base on basiscopic side, widest in middle. *Largest pinnae* 4.5 cm long, 1.5 cm wide above base; base truncate, slightly auricled especially on lower pinnae; apex abruptly short-pointed, edges lobed to a depth of 1.5–2 mm; costules 3.5–4 mm apart; veins 6–7 pairs,  $1\frac{1}{2}$  pairs anastomosing, 1 pair to sides of sinus-membrane; lower surface of rachis glabrous or sparsely hairy, of costae, costules and veins covered with slender appressed hairs, glands abundant throughout; upper surface covered with slender appressed hairs. *Fertile fronds*. *Pinnae* 2.8 cm long, 0.7–0.9 cm wide above base, lobed as sterile and similarly hairy and glabular; *sori* at maturity covering whole surface; indusia hairy; sporangia bearing glands; spores with a translucent wing and cross-wings.

Distr. *Malesia*: N. Celebes; only known from the type.

**29. *Pronephrium solsonicum* HOLTUM**, Kalikasan 3 (1974) 197. — Type: M. G. PRICE 2903, Luzon, Ilocos Norte, Solsona, 1100 m, in forest (K; PNH).

*Caudex* short-creeping; fronds dimorphous. *Sterile fronds*. Stipe 5–6 cm long, short-hairy near base, basal scales thin, 3 mm long. *Lamina* to 15 cm long; apex 8 cm long, deeply lobed; pinnae 9 pairs, basal pair slightly reduced and narrowed to base on basiscopic side. *Largest pinnae*  $2.1 \times 0.8$  cm; base truncate and slightly auricled; apex obtuse; edges lobed to a depth of 1 mm; costules 2.5 mm apart; veins slender, 3 pairs, basal pair anastomosing, next pair to edge; lower surface of rachis bearing coarse spreading pale hairs 1 mm long, hairs on costae and costules much shorter, slender, appressed, many glands on surface between veins; upper surface of rachis as lower, hairs on costae 0.5 mm long, similar hairs scattered on costules and veins, no others. *Fertile fronds*. Stipe 12–20 cm long; pinnae to  $1.4 \times 0.7$  cm, edges subentire or slightly crenate; *sori* near costules, indusia large, glabrous; sporangia bearing glands.

Distr. *Malesia*: Philippines (Luzon); only known from the type.

**30. *Pronephrium celebicum* (BAK.) HOLTUM**, Blumea 20 (1972) 119. — *Acrostichum celebicum* BAK. Kew Bull. (1901) 741. — *Leptochilus celebicus* (BAK.) C. CHR. Ind. Fil. (1905) 384; v.A.v.R. Handb. (1908) 741. — *Dryopteris celebica* (BAK.) COPEL. Philip. J. Sci. 37 (1928) 410. — *Thelypteris celebica* (BAK.) REED. Phytologia 17 (1968) 267. — Lectotype (HOLTUM 1972): DE LA SAVINIERRE 61, N. Celebes (K; P).

*Aspidium canescens forma acrostichoides* CHRIST, Ann. Jard. Bot. Btzig 15 (1898) 132. — *Dryopteris acrostichoides* (CHRIST) v.A.v.R. Handb. Suppl. (1917) Corr. 49, non O. Ktze 1891 excl. var. *rhombea* & var. *lanceola*. — Lectotype (HOLTUM 1972): KOORDERS 17153, N. Celebes (BO; L).

(?) *Meniscium hoesi* var. *sumbensis* v.A.v.R. Bull. Dép. Agr. Ind. Néerl. 21 (1908) 7. — *Phegopteris hoesi* var. *sumbensis* v.A.v.R. Handb. (1908) 510. — Type: TEYSMANN 10693, Sumba (BO?; not seen). — Fig. 15b–d.

*Caudex* short-creeping; fronds dimorphous. *Sterile fronds*. Stipe 6–15 cm long, pale, minutely hairy or glabrescent, basal scales thin, narrow, 3 mm long. *Lamina* thin, 15–18 cm long; apex acuminate and deeply lobed; pinnae 8–10 pairs, basal pinnae narrowed to base on basiscopic side, sessile or with a very short stalk. *Largest pinnae*  $4.2 \times 1.2$  cm (width above base); base truncate, strongly auricled on acroscopic side; apex short-acuminate; edges serrate-crenate to a depth of

1–1.5 mm; costules 2.5 mm apart; veins slender and little prominent, 4–5 pairs, 2 pairs anastomosing, sinus-membrane hardly evident; lower surface of rachis bearing hairs 0.3 mm long, pale, sometimes sparse, on costae and costules hairs much shorter and always sparse, surfaces between veins pustular; hairs on upper surface of rachis thick, to 0.5 mm long, on costae 0.2 mm, rather sparse, no others. Fertile fronds. Stipe 20–30 cm long; lamina to 25 cm; pinnae widely spaced, 2.5–4.0 cm long, 2–4 mm wide above auricled base, edges crenate; veins 3 pairs, basal pair only anastomosing; lower surface covered with sori (also upper surface near apex?); indusia very small with a few hairs; sporangia of type bearing both glands and short setae, of Curtis specimen (also cited by Baker) glands only; spores light brown, with a translucent wing and cross-wings.

Distr. *Malesia*: Celebes, Moluccas (Ceram, Tenimber Is.), West New Guinea (Vogelkop), and ? Lesser Sunda Is. (Sumba).

Notes. SARASIN 1022, from Central Celebes, cited by CHRIST with those of KOORDERS, has sterile pinnae to  $6 \times 1.5$  cm and sporangia strongly setiferous. v.A.v.R.'s description of *D. acrostichoides* was based on KOORDERS's specimens at Bogor named by CHRIST; these were not cited by CHRIST in 1898; I have selected KOORDERS 17153 as the type of v.A.v.R.'s name.

**31. *Pronephrium granulosum* (PRESL) HOLTUM**, Blumea 20 (1972) 119. — *Polypodium granulosum* PRESL, Rel. Haenk. (1825) 24, pl. 4, f. 2; HOLTUM, Novit. Bot. Inst. Bot. Univ. Carol. Prag. 1968 (1969) 19. — *Dryopteris granulosum* (PRESL) C. CHR. Ind. Fil. (1905) 269; CHRIST, Philip. J. Sci. 2 (1907) Bot. 217. — *Phegopteris granulosa* (PRESL) v.A.v.R. Handb. (1908) 503, p.p. — *Cyclosorus granulosus* (PRESL) COPEL. Fern Fl. Philip. (1960) 373, p.p. — *Thelypteris granulosa* (PRESL) REED, Phytologia 17 (1968) 280. — Type: HAENKE, Luzon (PRC; specimen at W is marked HAENKE 98).

*Dryopteris chamaetaria* CHRIST, Philip. J. Sci. 2 (1907) Bot. 203. — *Phegopteris chamaetaria* (CHRIST) v.A.v.R. Handb. (1908) 505. — *Thelypteris chamaetaria* (CHRIST) REED, Phytologia 17 (1968) 267. — Lectotype (COPELAND 1960): WHITFORD 1369, Luzon, Mt Mariveles (not found at MICH, P, US); Neotype (HOLTUM 1972): ELMER 6970, same locality (K).

*Dryopteris maquilungensis* COPEL. Philip. J. Sci. 56 (1935) 103, pl. 8. — Type: COPELAND s.n. Nov. 1932, Luzon, Mt Makiling (formerly in PNH); Neotype (HOLTUM 1972): ELMER 18169, same locality (K; BISH, G, L).

*Cyclosorus subdimorphus* COPEL. Philip. J. Sci. 81 (1952) 38; Fern Fl. Philip. (1960) 374. — *Thelypteris palawanensis* REED, Phytologia 17 (1968) 300, nom. nov. — Type: EDANO PNH 13925, Palawan (MICH). — Fig. 15m–n.

*Caudex* short to long-creeping, 3 mm diameter; fronds close or 1–2 cm apart, subdimorphous. Stipe 15–20 cm long (sterile) 30–45 cm (fertile); lamina of mature plants 15–24 cm long, thin but firm, consisting of apical section 8–15 cm long, 1.5–3.0 cm wide, and 2–4 pairs of pinnae; lowest pinnae stalked 1–2 mm, widest at about the middle, base asymmetric and  $\pm$  auricled. Middle pinnae to  $11 \times 2.5$  cm (sterile; fertile smaller, to  $9 \times 2.2$  cm); base truncate and slightly auricled; apex acuminate (narrowly on longest pinnae); edges crenate to depth of 1 mm (entire on pinnae of young plants); costules to 4 mm apart; veins 5–6(–8) pairs, slender and slightly prominent, 2–5 pairs anastomosing (according to width of pinnae); lower surface of rachis bearing a variable number of coarse pale hairs to 0.8 mm long; hairs on costae sparse and much shorter, surface between veins pustular and sometimes with very short erect hairs; upper surface of rachis covered with thick pale hairs 1 mm long, costal hairs rather sparse, 0.3 mm long, no other hairs. Sori inframedial; indusia small, soon caducous, dark red with short hairs on surface and margin; sporangia bearing glands and also short setae; spores with translucent wing and cross-wings.

Distr. *Malesia*: Philippines (Luzon, Palawan, Balabac, Panay, Mindanao).

Ecol. In forest at low altitudes, to 500 m.

Notes. One frond in HAENKE's collection at Prague has two pinnae widened and irregularly deeply lobed distally; PRESL named this *var. lobata*. This feature may indicate hybridity; it needs experimental investigation.

Young plants have much smaller pinnae than above described; the smallest fertile pinna seen measures  $4.5 \times 1.2$  cm. A specimen from Balabac (J. B. STEERE) has no glands on sporangia, and pinnae crenate to a depth of 2 mm; otherwise it is very near the type. A specimen from Mindanao has very narrow pinnae, the largest fertile one  $5.0 \times 0.8$  cm.

**32. *Pronephrium samarense* (COPEL.) HOLTUM**, Blumea 20 (1972) 119. — *Cyclosorus samarensis* COPEL. Philip. J. Sci. 81 (1952) 35. — *Thelypteris samarensis* (COPEL.) REED, Phytologia 17 (1968) 311. — Type: GACHALIAN PNH 15240, Samar (MICH; 15220 at SING).

*Caudex* short-creeping, 2 mm diameter; fronds dimorphous. Sterile fronds. Stipe 3–5 cm long, basal scales to 2 mm long, pale stiff hairs 0.7 mm long in the groove. Lamina 5–8 cm long; apex narrowly triangular, 2.5 cm long, lobed at base only; pinnae to 5 pairs, stalked 1 mm, lowest a little reduced and narrowed to base on basiscopic side. Largest pinnae 2–3 cm long, 0.8–1.0 cm wide; base subtruncate, slightly auricled on acroscopic side, rounded on basiscopic; apex obtusely pointed to rounded; edges entire; costules 2 mm apart; veins mostly 3 on basiscopic side of costule, 2 on



acroscopic, anastomosing to form one series of areoles with irregular additional ones; hairs on lower surface of rachis 0.3 mm long, on costae and costules shorter and sparse, no other hairs, surface between veins pustular; upper surface of rachis and costae similarly hairy, a few minute hairs present near margin. *Fertile fronds.* Stipe 8–18 cm long; lower pinnae widely spaced, largest pinnae to  $1.2 \times 0.5$  cm, shaped and stalked as sterile; costules simple or forked; where forked the branches anastomosing near margin; sori in one row on each side of costa with additional ones present in basal acroscopic lobe; indusia small, dark red, bearing short hairs; sporangia with 1 or 2 short setae.

Distr. *Malesia*: Philippines (Samar, 3 collections).

Ecol. Streambanks at c. 100 m.

**33. *Pronephrium x xiphioides* (CHRIST) HOLTUM**, *Blumea* 20 (1972) 119. — *Dryopteris xiphioides* CHRIST, *Philip. J. Sci.* 2 (1907) Bot. 201. — *Phegopteris xiphioides* (CHRIST) v.A.v.R. *Handb.* (1908) 501. — *Cyclosorus xiphioides* (CHRIST) COPEL. *Gen. Fil.* (1947) 143; *Fern Fl. Philip.* (1960) 349. — *Thelypteris xiphioides* (CHRIST) REED, *Phytologia* 17 (1968) 324. — Type: COPELAND s.n. April 1905, Mindanao, San Ramon (MICH).

*Cyclosorus edanyoi* COPEL. *Philip. J. Sci.* 81 (1952) 37; *Fern Fl. Philip.* (1960) 370. — *Thelypteris edanyoi* (COPEL.) REED, *Phytologia* 17 (1968) 274. — Type: Edaña BS 46065, Panay (UC).

*Dryopteris diversiloba sensu* CHRIST, *Philip. J. Sci.* 2 (1907) Bot. 199, excl. var. *acrostichoides*.

*Dryopteris rhombea sensu* COPEL. *Philip. J. Sci.* 56 (1935) 102, pl. 6, p.p. — *Cyclosorus rhombeus sensu* COPEL. *Fern Fl. Philip.* (1960) 357, p.p.

Plants with a frond-form intermediate between *P. granulosum* and *P. rhombeum*, with pinnae of irregular shape; young plants with lamina 4–5 cm long often with 2–3 pairs of pinnae; adult plants mostly with 4–6 pairs of pinnae (rarely 8 pairs); in almost all cases some or all pinnae, often also the apical lamina of the frond, irregularly dilated and irregularly  $\pm$  deeply lobed distally (see COPELAND 1935, line drawings on pl. 6); at least the lower pinnae  $\pm$  stalked as in *P. granulosum*; indusia small with a few short hairs; sporangia always setiferous.

Distr. *Malesia*: Philippines, widely.

Notes. These plants look like a hybrid swarm, which needs experimental cytotaxonomic investigation. The type collection of *P. granulosum* includes a frond with one pinna dilated and deeply lobed at the apex, indicating perhaps a slight degree of hybridity. Both parent species have very similar indusia; the sporangia of *P. granulosum* have glands on sporangia, but the hybrids do not. I have regarded this as an important distinction.

The type of *D. xiphioides* is the only specimen seen in which no pinnae are dilated distally.

**34. *Pronephrium trachyphyllum* HOLTUM, sp. nov.**

*Stipes frondis fertilis* 23 cm longus; lamina 14 cm longa pinnis 7-jugatis laminaque 5 cm longa constituta; pinnae usque  $3.0 \times 0.8$  cm, crenatae, eglandulosae, supra inter venas pilis minutis suberectis multis vestitae; sori inframediales, non elongati; indusia parva tenuia atrorubra, pilis multis  $0.2\text{--}0.3$  mm longis vestita; sporangia setis pluribus praedita. — Type: A. B. COLINA 772, Mindanao, Surigao (K ex CAHP).

*Caudex* short-creeping, bearing small sterile and much larger fertile fronds. *Sterile fronds.* Stipe 1.5 cm long; lamina 4 cm long, apex deltoid and lobed, pinnae 3–4 pairs, to  $1.3 \times 0.5$  cm, subentire. *Fertile fronds.* Stipe 10–23 cm long, minutely hairy; basal scales thin, narrow, to 3 mm long. Lamina 8–14 cm long; apex 3–4 cm long, rather deeply lobed throughout with some subapical lobes irregularly elongate; pinnae to 7 pairs; basal pinnae of largest frond not reduced but more widely spaced, not opposite, 3.0 cm long, 0.8 cm wide above base, somewhat dilated distally with a few lobes irregularly slightly elongate. *Suprabasal pinnae* 2.7 cm long, 0.8 cm wide above truncate and auricled base; apex abruptly obtuse; edges lobed to a depth of 1 mm; costules 2.5 mm apart; veins to 4 pairs,  $1\frac{1}{2}$  pairs anastomosing; lower surface of rachis covered with pale hairs  $0.2\text{--}0.3$  mm long, costae bearing pale spreading hairs of mixed length to 0.6 mm, sparse short hairs on costules and veins and between veins; hairs on upper surface of rachis 0.5 mm, on costae 0.2 mm, very short suberect hairs present on surface between veins. Sori inframedial, not elongate; indusia small, thin, dark red, with many stiff pale hairs  $0.2\text{--}0.3$  mm; sporangia with several short setae; spores pale with translucent wing and cross-wings.

Distr. *Malesia*: Philippines (Mindanao), only known from type.

Notes. It is possible that larger sterile fronds might be produced on other plants. The fertile fronds differ from those of *P. amphitrichum* (in which the upper surface is hairy in a similar way) in having larger pinnae, sori not elongate and setose sporangia. The smaller fertile fronds of the type have shallowly crenate pinnae, but agree with the largest in having irregular long lobes on the apical lamina. Such irregular lobes are sometimes a sign of hybridity, but there are abundant good spores.

**35. *Pronephrium thysanoides* HOLTUM, sp. nov.**

*P. simillimo* (C. Chr.) Holtum affinis, ab ea differt: frondibus minoribus; pinnis non auriculatis; rachide costisque subtus glabris; soris indusiatis, indusiis parvis, rigidis, setis brevibus

*ciliatis*. — Type: JERMY 14049, Sarawak, Gunong Mulu, Ulu Sungei Air Jernih, north wall (BM).

*Caudex* short-creeping; *stipe* 15–20 cm long, glabrous, basal scales narrow, firm, c. 3 mm long with few hairs; fronds of type all fertile. *Lamina* to 24 cm long; pinnae 15 pairs, lower ones only subopposite; apical lamina 4 cm long, deeply lobed at base and grading to upper pinnae; basal pinnae slightly narrowed towards their bases, more on basiscopic than on acroscopic side, not auricled. *Largest pinnae* 3.5 × 1.1 cm; base truncate; apex abruptly acute, ± upcurved; edges crenate to a depth of less than 1 mm; costules 3 mm apart, at c. 60° to costa; veins 4 pairs, slender, 1 or 1½ pairs anastomosing, next vein passing to the short sinus-membrane; *lower surface* of rachis and costae glabrous, of costules, veins and surface between veins bearing rather sparse very short hairs which may be abraded from old fronds; *upper surface* of rachis and costae bearing rather sparse pale hairs 0.3 mm long, rather sparse very short hairs between veins. *Sori* medial, small; indusia small but firm, with many short stiff marginal hairs; sporangia with several short setae; spores with many small wings.

Distr. *Malesia*: Borneo (Sarawak: Mt Mulu), only known from the type.

Ecol. "In clay in crevice of open rock-face", on limestone at 700 m.

**36. *Pronephrium hosei* (BAK.) HOLTUM**, Blumea 20 (1972) 120. — *Meniscium hosei* BAK. J. Linn. Soc. Bot. 22 (1886) 142. — *Dryopteris hosei* (BAK.) C. CHR. Ind. Fil. (1905) 271; COPEL. Philip. J. Sci. 10 (1915) Bot. 146. — *Phegopteris hosei* (BAK.) v.A.v.R. Bull. Dép. Agr. Ind. Néerl. 21 (1908) 7; Handb. (1908) 510. — *Cyclosorus hosei* (BAK.) COPEL. Gen. Fil. (1947) 142; Fern Fl. Philip. (1960) 352. — *Thelypteris hosei* (BAK.) K. IWATS. Acta Phytotax. Geobot. 21 (1965) 170. — Type: G. F. HOSE 160, Sarawak (K).

*Meniscium proliferum sensu* HOOK. 2 Cent. Ferns (1861) t. 15, *quoad plantam totam et fig. 2 tantum*.

*Caudex* short-creeping; fronds dimorphous. *Sterile fronds*. *Stipe* 5–15 cm long, minutely hairy at base, scales c. 2 × 1 mm, caducous. *Lamina* 12–15 cm long, firm; apex to 7 cm long, narrowly triangular, lobed near base only; pinnae 6–8 pairs; lower pinnae not or little reduced, in most cases narrowed slightly near base on basiscopic side, edges sometimes crenate. *Middle pinnae* to 5 cm long, 0.9 cm wide above base; base truncate, always auricled on acroscopic side, often slightly also on basiscopic; distal half of pinna evenly attenuate to narrow rounded apex; edges entire or ± crenate distally; costules 2 mm apart; veins 4–5 on basiscopic side of costules, 3–4 on acroscopic, to 7 pairs in basal auricle, 2 pairs anastomosing; sinus-membrane not evident; *lower surface* of rachis bearing curved hairs 0.5 mm long, hairs on

costae 0.1–0.2 mm, no other hairs except on margin, surface between veins very pustular; hairs of *upper surface* of rachis to 1 mm long, on costae copious, 0.3 mm long, some longer hairs present near edge. *Fertile fronds*. *Stipe* to 25 cm long; *lamina* 10–12 cm long; apex 2.5 cm long; pinnae to 9 pairs, to 3.0 cm long, 0.4 cm wide above auricled base; pubescence as sterile but hairs on rachis shorter; *sori* near costules, spreading somewhat long veins; indusia persistent, bearing many hairs 0.1 mm long; sporangia with 1–2 short setae; spores pale, with longitudinal wing and cross-wings. *Chromosomes*: n = 36 (T. G. WALKER).

Distr. *Malesia*: Borneo; Philippines (Mindanao: Zamboanga Prov., SANTOS 4114).

Ecol. On rocky stream-banks in forest, at low altitudes.

**37. *Pronephrium menisciicarpon* (BL.) HOLTUM**, Blumea 20 (1972) 111. — *Aspidium menisciicarpon* BL. En. Pl. Jav. (1828) 142. — *Dryopteris menisciicarpa* (BL.) POSTH. Bull. Jard. Bot. Btzig III, 13 (1933) 93; BACKER & POSTH. Varenfl. Java (1939) 61, excl. syn. *Dryopteris verruculosa* v.A.v.R. — *Abacopteris menisciicarpa* (BL.) HOLTUM, Rev. Fl. Malaya 2 (1955) 290, f. 168. — *Thelypteris menisciicarpa* (BL.) K. IWATS. Acta Phytotax. Geobot. 21 (1965) 171. — Type: BLUME, W. Java (L. n. 908, 333–724).

*Nephrodium latifolium* PRESL, Epim. Bot. (1851) 45, excl. CUMING 16; HOLTUM, Novit. Bot. Inst. Bot. Univ. Carol. Prag. 1968 (1969) 40. — *Cyclosorus latifolius* (PRESL) COPEL. Fern Fl. Philip. (1960) 370. — *Thelypteris latifolia* (PRESL) REED, Phytologia 17 (1968) 287. — Lectotype (HOLTUM 1969): CUMING 298, Leyte (PRC).

*Abacopteris truncata* FÉE, Gen. Fil. (1852) 310. — Type: CUMING 298 (not seen).

*Dryopteris holophylla* C. CHR. Ind. Fil. (1905) 271, *nom nov.* for *Polypodium holophyllum* BAK. J. Bot. 26 (1888) 325, *non* BAK. 1879. — *Phegopteris holophylla* (C. CHR.) v.A.v.R. Handb. (1908) 500. — Type: C. HOSE 242, Sarawak, Niah (K; E).

*Dryopteris cordifolia* v.A.v.R. Bull. Jard. Bot. Btzig II, 11 (1913) 19, pl. 5; Handb. Suppl. (1917) 320. — Type: AMDJAH 322 p.p. N. Borneo (BO; K, L).

*Dryopteris mirabilis* COPEL. Philip. J. Sci. 6 (1911) Bot. 137, pl. 19; v.A.v.R. Handb. Suppl. (1917) 174; C. CHR. Gard. Bull. Str. Settl. 4 (1929) 391; 7 (1934) 249. — Type: BROOKS 16a, Sarawak, Bidi (MICH; BM).

*Dryopteris korthalsii* ROSENST. Meded. Rijksherb. n. 31 (1917) 5. — Type: KORTHALS, Sumatra (L; K).

*Dryopteris verruculosa* var. *sumatrana* v.A.v.R. Bull. Jard. Bot. Btzig III, 2 (1920) 151. — Type: BROOKS 157/S, Sumatra, Lebong Tandai (BO; BM).

*Dryopteris urophylla* var. *peraspera* v.A.v.R.

Bull. Jard. Bot. Btztg III, 5 (1922) 303. — Type: LAM 666, W. New Guinea (BO; L).

*Nephrodium glandulosum sensu* BEDD. Handb. Suppl. (1892) 70, p.p.

*Caudex* short-creeping; fronds tufted, dimorphous. *Sterile fronds*. *Stipe* to 20 cm long, minutely hairy; basal scales thin, broad, soon shrivelling. *Lamina* 30–40 cm long, consisting of 4–6(–8) pairs of pinnae and an apical lamina which is longest on fronds with few pinnae; young plants in Borneo (*D. holophylla*) have simple fronds to 25 × 8 cm with cordate base. *Pinnae* to 13.5 × 4.5 cm, usually widest at or above the middle; base truncate with a slight acroscopic auricle (especially on lower ones); apex abruptly short-pointed; edges ± crenate distally; costules to 4 mm apart; veins to 10 pairs, anastomosing to form a zig-zag excurrent vein; *both surfaces* of rachis covered with coarse pale hairs, those on costae much shorter, sparse on costules, surface between veins strongly pustular. *Fertile fronds*. *Stipe* to 45 cm long; *pinnae* more widely spaced than sterile ones, commonly 7 × 1.5 to 10 × 2.5 cm (on some plants much smaller), shape as sterile but edges almost entire; *sori* medial to supramedi- al, slightly elongate; indusia with many short hairs; sporangia bearing 0–2 setae; spores with longitudinal wing and cross-wings.

*Distr. Malesia*: Sumatra, Malaya, Borneo, W. Java; Philippines (Samar, Leyte); W. New Guinea, Papua, New Britain.

*Ecol.* In forest near streams at low altitudes.

*Notes.* In Malaya (Pahang and Perak) plants grow on earthen banks of streams; in such places they are swept away by floods before they have attained their full size, but they commonly produce fertile fronds with pinnae to c. 3.0 × 0.6 cm. Young plants with very large simple fronds like the type of *Dryopteris holophylla* have not been found in Malaya, but the largest adult specimens from Malaya are not different from those from Borneo. In the Philippines the largest simple fronds seen are 18 × 6 cm (sterile) and 13 × 4 cm (fertile). The type of *Dryopteris korthalsii* has up to 6 pairs of rather small fertile pinnae (4 × 1.3 cm); there are similar fronds from Borneo with pinnae 10 × 2 cm.

Under the name *Aspidium menisciocarpon* BL. METTENIUS described a specimen of a species of *Tectaria* from the Philippines; his description was copied by HOOKER who transferred the name to *Polypodium*. BEDDOME's description of *Nephrodium glandulosum* (Handb. Suppl. 70) was based mainly on specimens cited which belong to the present species, but in part on the true *Aspidium glandulosum* BL. CHRISTENSEN (Ind. Fil. 1905) confused the present species with *A. lineatum* BL. and *A. affine* BL.

**38. *Pronephrium hewittii* (COPEL.) HOLTTUM, comb. nov.** — *Dryopteris hewittii* COPEL. Philip.

J. Sci. 3 (1909) Bot. 344; v.A.v.R. Handb. Suppl. (1917) 189. — *Thelypteris hewittii* (COPEL.) REED, Phytologia 17 (1968) 282. — Type: BROOKS & HEWITT s.n. Feb. 1908, Sarawak, Bongo Range (MICH).

*Dryopteris compacta* COPEL. Philip. J. Sci. 6 (1911) Bot. 137, pl. 18; v.A.v.R. Handb. Suppl. (1917) 176. — *Thelypteris compacta* (COPEL.) REED, Phytologia 17 (1968) 268. — Type: BROOKS 4, Sarawak, Bongo Range (MICH; BM). — Fig. 15e–i.

*Caudex* short-creeping; fronds subdimorphous. *Sterile fronds*. *Stipe* 10–15 cm long, glabrous; basal scales thin, to 3 × 1 mm. *Lamina* to 25 cm long; apex narrowly acuminate, to 5 × 1 cm, lobed at base; *pinnae* to 20 pairs, close, spreading at right angles to rachis; lower pinnae deflexed, narrowed to base on both sides, with a small acroscopic auricle. *Middle pinnae* 4–6 cm long, 0.9–1.1 cm wide above the truncate and strongly auricled base; apex acuminate; edges crenate throughout, distally to a depth of 1 mm; costules 2.5–3 mm apart, at 45° to costa; veins to 3 pairs, 1½–2 pairs anastomosing, sinus-membrane distinct but very short; *lower surface* of rachis glabrous, of costae bearing scattered hairs 0.5 mm long, a few shorter hairs on costules and veins, surface between veins slightly pustular; *upper surface* of rachis bearing thick pale hairs 1 mm long, costae covered with hairs 0.2–0.3 mm long, a few longer ones near ends of veins. *Fertile frond*. *Stipe* to 25 cm long; *pinnae* to 4 cm long, 0.5–0.9 mm wide, auricled as sterile but usually less deeply crenate; *sori* near costules; indusia firm, dark, almost circular with hairs in the middle; sporangia not setiferous.

*Distr. Malesia*: Borneo (Western Sarawak, 4 collections).

*Ecol.* "On small rock well above stream" (MOLESWORTH ALLEN 3048, foot of Gunong Santubong).

*Notes.* The type of *D. hewittii* is a small plant with dimorphic fronds; that of *D. compacta* much larger with fertile pinnae nearly as wide as sterile; two later collections have narrower fertile pinnae. In 1972 I united this species with *P. merrillii* but the latter is quite distinct in venation and sori.

**39. *Pronephrium affine* (BL.) PRESL, Epim. Bot. (1851) 259; HOLTTUM, Blumea 20 (1972) 121, excl. syn. praeter BL. et *Gymnogramme macrotis* KUNZE.** — *Aspidium affine* BL. En. Pl. Jav. (1828) 148. — Type: BLUME, W. Java (L, n. 908, 333–740).

*Gymnogramme macrotis* KUNZE, Bot. Zeit. 6 (1848) 114. — *Dryopteris oxyotis* ROSENST. Meded. Rijksherb. n. 31 (1917) 5, nom. nov. (not *D. macrotis* (HOOK.) O. Ktze). — Type: ZOLLINGER 324z, Java (L).

*Aspidium lineatum sensu* METT. Farngatt. IV (1858) 110, quoad syn. *A. affine* BL. et *G. macrotis*

KUNZE *tantum*. — *Nephrodium lineatum* sensu HOOK. Spec. Fil. 4 (1862) 75, p.p.; RACIB. Fl. Btzg 1 (1898) 186. — *Dryopteris lineata* sensu C. CHR. Ind. Fil. (1905) 63, 275, p.p.; sensu v.A.v.R. Handb. (1908) 209; sensu BACKER & POSTH. Varenfl. Java (1939) 60.

*Caudex* short-creeping or suberect; fronds dimorphous. *Sterile fronds*. *Stipe* 15–20 cm long, glabrous except in groove, basal scales very thin, to 4 × 2 mm. *Lamina* to 25 cm long, thin; apex small and deeply lobed; pinnae to 12 pairs; basal pinnae somewhat narrowed towards base both sides with acroscopic auricle. *Middle pinnae* of type 4 × 1.7 cm (width above base), of a Sumatran specimen 7 × 2.0 cm; base truncate with acroscopic auricle 2–4 mm long; apex of type abruptly short-pointed, of Sumatran specimen short-acuminate; edges crenate throughout in smaller plants, distally on larger ones; costules 3–3.5 mm apart, at less than 60°; veins 5–6 pairs, 3–3½ pairs anastomosing, sinus-membrane very short; *lower surface* of rachis bearing coarse hairs to 0.7 mm long, hairs on costae 0.1 mm, sometimes with a few longer ones, similar hairs distally on costules and veins, surface between veins pustular; hairs on *upper surface* of rachis to 0.5 mm long, very short on costae and scattered distally on veins, none between veins. *Fertile fronds*. *Stipe* to 35 cm long; *pinnae* of type 3.0 × 0.7 cm, of others to 4.0 × 0.9 cm, base strongly auricled (sometimes on both sides), edges almost entire; veins to 4 pairs; *sori* medial, slightly elongate; indusia thin, bearing copious acicular hairs 0.1–0.2 mm or sometimes short capitate hairs; sporangia lacking setae; spores pale with a rather broad continuous wing and cross-wings.

*Distr.* Peninsular Thailand, in *Malesia*: Central & S. Sumatra, West Java.

*Ecol.* By streams in forest, low altitudes.

*Notes.* The description by METTENIUS of *A. lineatum* was evidently based on specimens of several distinct species, doubtfully including the type of *A. affine*; it was copied by HOOKER who varied the list of synonyms, and the status of *A. affine* as a synonym of *A. lineatum* was accepted by CHRISTENSEN, who cannot have read BLUME's descriptions. But the descriptions of RACIBORSKI, VAN ALDERWERELT and BACKER & POSTHUMUS clearly apply to the present species only.

BLUME's type matches specimens from a low altitude in Sumatra which, like BLUME's, were found on limestone rocks by streams. A specimen from Pattani in Thailand is similar.

**40. *Pronephrium borneense* (HOOK.) HOLTUM, comb. nov.** — *Polypodium borneense* HOOK. Spec. Fil. 5 (1863) 11. — *Dryopteris labuanensis* C. CHR. Ind. Fil. (1905) 273, nom. nov. (not *D. borneensis* (HOOK.) O. Ktze). — *Phegopteris borneensis* (HOOK.) v.A.v.R. Handb. (1908) 500. —

*Thelypteris borneensis* (HOOK.) REED, *Phytologia* 17 (1968) 264. — Type: T. LOBB, Labuan (K).

*Caudex* short-creeping; fronds not or little dimorphous. *Stipe* to 12 cm long, pale, minutely hairy; basal scales thin, c. 2 × 1 mm. *Lamina* thin, to 18 cm long; apex 6–9 cm long, triangular, lobed near base which is 3–4 cm wide; pinnae 4–5 pairs, not opposite; basal pinnae narrowed towards base on basiscopical side, slightly so to auricled acroscopic base. *Middle pinnae* 3.5 × 1.5 to 5.0 × 2.2 cm; base truncate with auricle 2–3 mm long; apex abruptly short-pointed; edges shallowly crenate throughout; costules 2.5–3 mm apart; veins 6 pairs, slender, at a broad angle to costules, almost all anastomosing to form a zig-zag excurrent vein (rarely with gaps in it), sinus-membrane not evident; *lower surface* of rachis and costae sparsely short-hairy, rest glabrous and slightly pustular; *upper surface* of rachis with copious hairs 0.2–0.7 mm long, costal hairs 0.3 mm, a few short hairs also present near margin. *Sori* small, not elongate, mostly medial; indusia very small (sometimes lacking?), red when young, variable in shape, with a few mostly marginal hairs 0.1 mm long; sporangia with 4–5 short setae; spores with a narrow wing and a few cross-wings.

*Distr. Malesia*: Borneo (Sarawak, Sabah).

*Ecol.* "Hill forest, on clay bank, 420 m" (JERMY 13072, G. Mulu); "on wet rocks, 300 m" (BROOKS 16c, Bongo Range).

*Notes.* The type is a single fertile frond. Living plants of JERMY 13072, cultivated at Kew, resemble the type closely and have sterile and fertile fronds of similar size; the above description is based on the type and cultivated plants. Dried specimens of JERMY 13078, also from G. Mulu, are larger, with stipes 30 cm long and dimorphous fronds to 30 cm long with 6 pairs of pinnae; sterile pinnae to 8.5 × 2.8 cm (veins 7 pairs), fertile to 4.5 × 1.6 cm.

**41. *Pronephrium exsculptum* (BAK.) HOLTUM, Blumea 20 (1972) 117.** — *Acrostichum exsculptum* BAK. J. Bot. 26 (1888) 326. — *Leptochilus exsculptus* (BAK.) C. CHR. Ind. Fil. (1905) 9, 385; v.A.v.R. Handb. (1908) 740. — *Dryopteris exsculpta* (BAK.) COPEL. Philip. J. Sci. 37 (1928) 410; C. CHR. Gard. Bull. Str. Settl. 7 (1934) 248, p.p. — *Thelypteris exsculpta* (BAK.) K. IWATS. Acta Phytotax. Geobot. 21 (1965) 170. — Type: C. HOSE 244, Sarawak, Niah (K).

*Menisicium stenophyllum* BAK. J. Bot. 29 (1891) 108. — *Phegopteris stenophylla* (BAK.) v.A.v.R. Handb. (1908) 510. — *Thelypteris stenophylla* (BAK.) REED, *Phytologia* 17 (1968) 315. — Type: G. F. HOSE 20, Sarawak (K).

*Caudex* short-creeping; fronds dimorphous. *Sterile fronds*: *Stipe* 10–17 cm long, glabrous except distally; basal scales to 5 × 1 mm, dark, firm. *Lamina* 25 cm long, very firm; apex small, triangular, deeply lobed; pinnae 20–25 pairs; basal

pinnae slightly narrowed both sides towards auricled base. *Middle pinnae*  $3.5 \times 1.0$  cm; base truncate, slightly auricled; apex short-acuminate (pinnae of type of *M. stenophyllum* to  $2.0 \times 0.8$  cm, apex shortly obtuse); edges crenate to a depth of 0.5 mm; costules 2–2.5 mm apart; veins 3 pairs, thick, pale and prominent on lower surface, 2 pairs anastomosing, sinus-membrane not evident; lower surface of rachis bearing thick curved hairs less than 0.5 mm long, a few minute hairs on costae, rest of surface glabrous, not or hardly pustular; upper surface of rachis as lower, sparse short hairs on costa. *Fertile fronds*: Stipe 25 cm or more long; pinnae to 2.0 cm long (type of *M. stenophyllum* 1.0 cm), 0.3–0.4 cm wide above base which is strongly auricled (sometimes both sides); veins 2 pairs; sori near costules, at maturity filling lower surface; indusia small with a few very short marginal hairs; sporangia not setiferous; spores not seen.

Distr. *Malesia*: Borneo (Sarawak).

Ecol. Probably on limestone.

Note. CHRISTENSEN (l.c. 1934) referred here specimens with thinner pustular pinnae and setiferous sporangia; these are now placed in *P. rhombeum* and *P. peltatum*.

**42. *Pronephrium merrillii*** (CHRIST) HOLTUM, *Blumea* 20 (1972) 117. — *Dryopteris merrillii* CHRIST, Philip. J. Sci. 2 (1907) Bot. 201. — *Phegopteris merrillii* (CHRIST) v.A.v.R. Handb. Suppl. (1917) 505. — *Cyclosorus merrillii* (CHRIST) COPEL. Gen. Fil. (1947) 143; Fern Fl. Philip. (1960) 352. — *Thelypteris merrillii* (CHRIST) REED, *Phytologia* 17 (1968) 292. — Type: FOX-WORTHY 742, Palawan (P).

Differs from 38. *P. Hewittii* as follows: fertile pinnae to  $2.7 \times 0.4$  cm, entire or nearly so; indusia very small, asymmetric, with a few very short marginal hairs.

Distr. *Malesia*: Philippines (Palawan, 2 collections; second is ELMER 13031).

**43. *Pronephrium rhombeum*** (CHRIST) HOLTUM, *Blumea* 20 (1972) 120. — *Dryopteris diversiloba* var. *acrostichoides* subvar. *rhombea* CHRIST, Philip. J. Sci. 2 (1907) Bot. 200. — *Dryopteris acrostichoides* var. *rhombea* (CHRIST) v.A.v.R. Handb. Suppl. (1917) Corr. 49. — *Dryopteris rhombea* (CHRIST) COPEL. Philip. J. Sci. 56 (1935) 102, pl. 6 quoad icon. photogr. tantum. — *Cyclosorus rhombeus* (CHRIST) CHING, Bull. Fan Mem. Inst. Biol. Bot. 8 (1938) 192; COPEL. Fern Fl. Philip. (1960) 357, p.p. — *Thelypteris rhombea* (CHRIST) REED, *Phytologia* 17 (1968) 309. — Lectotype (COPELAND 1935): CUMING 149, Luzon (orig. PNH destroyed; isotype K).

*Dryopteris diversiloba* var. *acrostichoides* subvar. *lanceola* CHRIST, l.c. — *Dryopteris acrostichoides* var. *lanceola* (CHRIST) v.A.v.R., l.c. — *Dryopteris lanceola* (CHRIST) COPEL. Philip. J.

Sci. 56 (1935) 102, pl. 7. — *Cyclosorus lanceolus* (CHRIST) COPEL. Gen. Fil. (1947) 142; Fern Fl. Philip. (1960) 353. — *Thelypteris lanceola* (CHRIST) REED, *Phytologia* 17 (1968) 286. — Lectotype (COPELAND 1935): COPELAND 250, Luzon, Mt Mariveles (orig. PNH destroyed; isotypes K, MICH, US). — Fig. 15j–l.

*Caudex* short-creeping; fronds dimorphous. *Sterile fronds*. Stipe 5–8 cm long with pale hairs 1 mm long throughout. *Lamina* to 15 cm long, thin but firm; apex narrowly triangular, longer than pinnae; pinnae 8–(10) pairs; basal pinnae not or little narrowed towards base. *Middle pinnae* 2.0–3.5 cm long, 0.7–1.0 cm wide above auricled base; apex abruptly acute or obtuse, sometimes a little dilated; edges crenate, more deeply towards apex; costules 2 mm apart, at little more than  $45^\circ$  to costa; veins mostly 3 pairs, concolorous and slightly prominent, 2 pairs anastomosing, sinus-membrane not evident; lower surface of rachis bearing pale hairs 0.7 mm long, a few similar hairs with shorter ones present on costae, sparse short hairs on costules and veins, surface between veins pustular; upper surface of rachis hairy as lower, hairs on costae 0.2–0.3 mm long, a few short hairs near margin. *Fertile fronds*. Stipe to 25 cm long; lamina 10–20 cm long, in the latter case pinnae more widely spaced; pinnae 2.0–3.0 cm long, 0.4–0.6 cm wide, base auricled, edges almost entire; sori near costules, not elongate; indusia small, red, with marginal hairs 0.2–0.3 mm long; sporangia mostly with 2–3 short setae (in some cases none); spores with translucent wing and cross-wings.

Distr. *Malesia*: Philippines (Luzon to Mindanao), N. Borneo, Celebes.

Notes. The Kew isotypes of the lectotypes cited do not differ in the ways indicated in COPELAND's keys and descriptions of 1960, and among many specimens seen I cannot see two distinct forms. The Kew specimen of COPELAND 250 has pinnae more dilated distally than that of CUMING 149, though COPELAND indicates the contrary. The pinnae with irregular large distal lobes figured (as line drawings) with the photograph of the type of *D. rhombea* by COPELAND (1935) are representative of a group of forms, almost always with 4–5 pairs of pinnae, which appear to be hybrids and are here treated as *P. × xiphioides*.

**44. *Pronephrium peltatum*** (v.A.v.R.) HOLTUM, *comb. nov.* — *Dryopteris peltata* v.A.v.R. Bull. Jard. Bot. Btzig II, 16 (1914) 12; Handb. Suppl. (1917) 190. — *Thelypteris peltata* (v.A.v.R.) REED, *Phytologia* 17 (1968) 303. — Type: MATTHEW 632, Sumatra, Gunong Tandikat (BO).

*Dryopteris zippellii* ROSENST. Meded. Rijksherb. n. 31 (1917) 6. — Type: ZIPPEL, Java (L).

*Dryopteris lineata* var. *subacrostichoides*

v.A.v.R. Bull. Jard. Bot. Btzg II, 28 (1918) 24. — Type: CRAMER 37, S. Sumatra, Kota Agoeng (BO).

#### KEY TO THE VARIETIES

1. Indusia glabrous; sporangia not setiferous.
2. Sterile pinnae thin, margin deeply serrate distally . . . . . **a. var. peltatum**
2. Sterile pinnae rigid when dry, entire . . . . . **b. var. tenompokense**
1. Indusia with a few short hairs; sporangia setiferous or not.
3. Sporangia not setiferous . . . . . **c. var. peninsulare**
3. Sporangia setiferous.
4. Sporangia with several setae; basal pinnae not reduced . . . . . **d. var. persetiferum**
4. Sporangia with 0–2 setae; reduced basal pinnae present on most specimens . . . . . **e. var. aberrans**

#### a. var. peltatum

Stipe of sterile frond 14 cm long, of fertile 20 cm. Lamina to 21 cm long; pinnae c. 10 pairs. Sterile pinnae to 6 cm long, base rounded on basiscopic side and auricled on acroscopic, 1.5 cm wide above base, apex short-acuminate, edges crenate throughout or in distal part only; costules 2.5 mm apart; veins 3–4 pairs, almost all anastomosing; lower surface glabrous, pustular when dry; upper surface hairy on costae only. Fertile pinnae to 4 × 1 cm; sori medial; indusia firm, dark, lacking acicular hairs; sporangia not setiferous.

Distr. *Malesia*: Central & S. Sumatra, W. Java, at 900–1500 m.

Note. Specimens from Tjibodas in W. Java have sterile pinnae to 8 × 1.6 cm. One specimen from Sumatra has lower sterile pinnae auricled on both sides at the base.

**b. var. tenompokense** (C. CHR.) HOLTUM, *stat. nov.* — *Dryopteris tenompokensis* C. CHR. Gard. Bull. Str. Settl. 7 (1934) 248. — Type: HOLTUM 25388, Sabah, Mt Kinabalu, Tenompok (BM; K, SING).

Differs from *var. peltatum* as follows: texture of lamina firm; edges of pinnae almost entire;

lower surface of costae glabrous or sparsely minutely hairy.

Distr. *Malesia*: Sabah (Mt Kinabalu).

Ecol. In forest, on rocks by streams or near streams, at 1500 m.

**c. var. peninsulare** HOLTUM, *var. nov.* — *Abacopteris lineata sensu* HOLTUM, Rev. Fl. Mal. 2 (1955) 292, excl. syn., f. 169. — Type: A. G. PIGGOTT 1668, Malaya, Negri Sembilan, G. Telapak Burok, 900 m (K).

A *var. tenompokense* differt indusiis semper breviter pilosis.

Distr. *Malesia*: Malaya, on Main Range and Taiping Hills.

Ecol. In forest, not (or not always) by streams, 900–1500 m.

Note. A plant of this variety from Taiping Hills, cultivated at Kew, was found by MANTON to be tetraploid (HOLTUM l.c. p. 625).

**d. var. persetiferum** HOLTUM, *var. nov.* — *Dryopteris exsculpta sensu* C. CHR. Gard. Bull. Str. Settl. 7 (1934) 248, p.p. — Type: HOLTUM s.n. 1931, Mt Kinabalu, crest of Penibukan Ridge, 1200 m (SING; BM).

A *var. tenompokense* differt pinnis leviter crenatis, sporangiis setis pluribus praeditis.

Distr. *Malesia*: Borneo. Besides type, known from G. Mulu, Sarawak, in stream-bed at 1760 m.

**e. var. aberrans** HOLTUM, *var. nov.*

A *var. tenompokense* differt: frondibus pinnis inferioribus redactis usque 12-jugatis, aequaliter bilobatis (lobis usque 1.2 cm longis) praeditis; pinnis normalibus sterilibus usque 12 × 2.5 cm, distaliter crenatis, fertilibus usque 7 × 1.7 cm; sporangiis 0–2 setis praeditis. — Type: CLEMENS "33702 & 32020", Sabah, Mt Kinabalu, Colompon Basin, 1400–1600 m (K; G, MICH).

Distr. *Malesia*: Sabah.

Note. These specimens have the frond-form of *Sphaerostephanos*, but the reduced basal pinnae are not like those of that genus; apart from size, the normal pinnae agree with the present species. Spores of a specimen at MICH are normal.

## 2. Subgenus *Menisciopsis* HOLTUM, *subg. nov.*

*Pinnae subintegrae, plurivenosae, venis plerisque more generis Meniscii Schreb. anastomosantibus; sori exindusiati, saepe elongati, interdum coalescentes; sporangia vel nudis vel pilis rectis vel hamatis praedita.*

Type species: *Pronephrium lakhimpurens* (ROSENST.) HOLTUM, Blumea 20 (1972) 110.

Taxon. The type species, *P. lakhimpurens*, is distributed from N.E. India to southern China and southwards to northern Thailand and Vietnam. It has large entire pinnae with many pairs of anastomosing veins, the excurrent veinlets all free; the sori of large plants spread all along the veins, the sporangia

lacking setae. In these characters it is very close to the species of *Meniscium* of tropical America, and differs from them most conspicuously in the red colour of dried fronds. Another species of the same distribution in Asia, *P. penangianum* (HOOK.) HOLTUM, has narrower pinnae which are strongly crenate-serrate and distal excurrent veinlets not free. In Malesia, *P. rubrinerve*, *P. rubidum* and *P. scopulorum* are clearly related to the two species of mainland Asia, but their sori are not more than slightly elongate; only in *P. rubidum* are excurrent veinlets all free.

Agreeing with the species mentioned above in the reddish colour of dried fronds and also in elongate sori are species of another Malesian group which are distinguished by having hooked hairs on frond-axes and usually also on sporangia; formerly these species were all included in *Meniscium*. Several of them have buds at the bases of pinnae. They are here included in section *Grypothrix*.

There remain three species which appear to be somewhat intermediate between the two groups above mentioned. Of these, *P. acanthocarpum* has buds at the bases of its pinnae as in sect. *Grypothrix* but sori not elongate and straight setae on its sporangia. The other two, *P. nitidum* and *P. repandum*, have similar sori and sporangia but no buds on the frond; they are very similar to each other in general aspect but differ in sporangia and spores. They are possibly a connecting link between subgenera *Pronephrium* and *Menisciopsis*. They are here placed in section *Menisciopsis*.

The earlier-described species of this group were much confused by HOOKER, and it was not until the work of CHING in 1938 that their taxonomy and nomenclature were clarified. CHING however did not notice the hooked hairs which are the distinctive feature of sect. *Grypothrix*.

3. Section Menisciopsis

KEY TO THE SPECIES

- 1. Body of sporangium lacking setae.
  - 2. Pinnae 4–6 cm wide; edges distinctly serrate throughout . . . . . 45. *P. rubrinerve*
  - 2. Pinnae 2.5–3.5 cm wide; edges entire or nearly so.
    - 3. Excurrent veinlets mostly free; sori close to costules . . . . . 46. *P. rubidum*
    - 3. Excurrent veinlets mostly not free; sori not close to costules . . . . . 47. *P. scopulorum*
- 1. Body of sporangium bearing setae.
  - 4. Pinnae one pair, a bud at the base of each . . . . . 48. *P. acanthocarpum*
  - 4. Pinnae several pairs on adult plant; no buds present.
    - 5. Caudex long-creeping; veins very oblique; several acicular hairs on stalk of sporangium . . . . . 49. *P. nitidum*
    - 5. Caudex short-creeping; veins at a broad angle to costules; a hair of 2–3 cells, not acicular on stalk of sporangium . . . . . 50. *P. repandum*

**45. *Pronephrium rubrinerve* (METT.) HOLTUM**, Blumea 20 (1972) 110; Allertonia 1 (1977) 213; BROWNLIE, Pterid. Fiji (1977) 258. — *Phegopteris rubrinervis* METT. in Kuhn, Linnaea 36 (1869) 116; KUHN, Verh. Zool. Bot. Ges. Wien 19 (1869) 576; v.A.v.R. Handb. Suppl. (1917) 316. — *Goniopteris rubrinervis* (METT.) CARR. in Seem. Fl. Vit. (1873) 366. — *Polypodium rubrinerve* (METT.) BAK. Syn. Fil. ed. 2 (1874) 315. — *Cyclosorus rubrinervis* (METT.) COPEL. Gen. Fil. (1947) 143; J. Arn. Arb. 30 (1949) 438. — *Thelypteris rubrinervis* (METT.) K. IWATS. Mem. Coll. Sci. Univ. Kyoto B, 31 (1965) 195. — Lectotype (HOLTUM 1972): TURNER, New Ireland (B).  
Caudex massive, short-creeping to suberect; fronds closely tufted; scales small, thin, broad-ovate, glabrous or nearly so. Stipe to 145 cm long, glossy, glabrous apart from a few very short acicular hairs near base (often lost), drying light reddish; lamina to 170 cm long, thin but firm, drying brown-olivaceous with red costae and in some cases costules; pinnae to 24 pairs, upper ones on large fronds gradually decrescent; apex

pinna-like; basal pinnae distinctly stalked, narrowly cuneate at base, the lamina on basiscopic side ending 1.5–2.0 cm from rachis. Largest pinnae to 43 × 6 cm; base broadly cuneate; apical half gradually narrowed to short-acuminate tip; edges crenate to a depth of 1 mm, cartilaginous margin thick, pale to reddish; costules 4–5 mm apart, at 60° to costa, falcate distally; veins 15–20 pairs, at 45° to costules, almost straight, fine and slightly prominent on lower surface, almost all anastomosing, excurrent veinlets, except basal ones, rarely free; lower surface of rachis and pinnae quite glabrous (young fronds may have thin reddish scales on rachis and costae), surface between veins slightly pustular; upper surface of both rachis and costae glabrous. Sori medial or supramedial, basal ones sometimes meeting and slightly elongate; no indusia; sporangia lacking setae, a hyaline hair of 2 cells on the sporangium-stalk; spores red-brown, with a rather broad translucent wing and cross-wings.  
Distr. Polynesia (Fiji), Melanesia (New Hebrides) and Malesia: New Guinea (New Ireland).

Ecol. On river banks in forest at low altitude (to 900 m in Fiji).

Notes. In 1977 I reported the caudex of this species to attain a height of 30 cm, on the evidence of a herbarium label; but BRAITHWAITE reports it to be prostrate, and this is also true of a plant he sent from the New Hebrides, cultivated at Kew.

**46. *Pronephrium rubidum* (HOOK.) HOLTUM**, Blumea 20 (1972) 111. — *Polypodium rubidum* HOOK. Spec. Fil. 5 (1863) 12, excl. DE VRIESE 41. — *Dryopteris rubida* (HOOK.) C. CHR. Ind. Fil. (1905) 289; CHRIST, Philip. J. Sci. 2 (1907) Bot. 207, excl. WHITFORD 272. — *Phegopteris rubida* (HOOK.) v.A.v.R. Handb. (1908) 502. — *Cyclosorus rubidus* (HOOK.) COPEL. Gen. Fil. (1947) 143; Fern Fl. Philip. (1960) 375. — *Thelypteris rubida* (HOOK.) K. IWATS. Mem. Coll. Univ. Kyoto B, 31 (1965) 195. — Type: CUMING 415, Luzon (K; E, FI-W, G, LE, P).

Caudex short, suberect. *Stipe* dark reddish, glabrous except for minute hairs near base, to 100 cm long; basal scales not seen, reported by CHRIST to be 2 cm long. *Lamina* to 120 cm long; apex pinna-like; pinnae to 20 pairs, subopposite, drying dark reddish; basal pair not or little reduced, with stalks 1–2 mm long. *Largest pinnae* of type  $21 \times 2.7$  cm, largest seen  $28 \times 3.8$  cm; base cuneate (angle c.  $45^\circ$  each side); apex caudate-acuminate (cauda 2.5–3.0 cm long); edges irregularly slightly sinuous to slightly crenate, cartilaginous margin rather broad and red; costules 3–5 mm apart, at  $60^\circ$ ; veins 9–13 pairs, at  $45^\circ$  to costules, slightly curved, dark and not prominent on lower surface, excurrent veinlets all free; *lower surface* of rachis and pinnae quite glabrous; *upper surface* of rachis with a few short hairs in the groove, hairs on costae sparse, slender. *Sori* very close to costules except basal basiscopic ones on large pinnae, sporangia few; no indusia; no setae on body of sporangia; hair on sporangium-stalk 3-celled, distal cell not much enlarged.

Distr. *Malesia*: Philippines (Luzon; Palawan, 4 collections).

Ecol. "Streamside, in open pine forest, 1700 m" (PRICE 2831; no other record).

Notes. The largest specimen is FOXWORTHY 684 from Palawan (MICH). HOOKER described *var. β*, but he cited no specimen and I have not found one so marked. DE VRIESE 41, wrongly cited by HOOKER, is *P. ramosii*, as also WHITFORD 272 wrongly cited by CHRIST.

**47. *Pronephrium scopulorum* HOLTUM, sp. nov.**

A *P. rubido* differt: *pinnis omnibus basi anguste inaequaliter cuneatis, pinnis basalibus non stipitatis; venulis excurrentibus plerisque non liberis; soris costulas non contingentibus*. — Type: BUWALDA 5168, Aru Is., P. Kabroor, on limestone (K; BO).

Caudex not seen. *Stipe* probably to 50 cm long, dark reddish, glabrous; basal scales not seen. *Lamina* c. 50 cm long; apex pinna-like; pinnae to 8 pairs, firm, drying dull reddish, subopposite; bases of all pinnae narrowly unequally cuneate, lowest pinnae with narrowest base. *Middle pinnae*  $18 \times 2.8$ –3.5 cm, widest 1/3 from base; acroscopic base narrowed to attachment to rachis, lamina on basiscopic side ending 3–4 mm from rachis; apex narrowly caudate; edges entire or slightly sinuous distally; costules 3–4 mm apart at  $60^\circ$  to costa; veins to 10 pairs, at c.  $45^\circ$  to costules, almost straight, almost all anastomosing to form zig-zag excurrent veins between costules, basal basiscopic vein arising from costa; *both surfaces* quite glabrous (upper surface of rachis and costae probably have some hairs when pinnae are young). *Sori* near costules but not touching them, basal ones sometimes supramedial; no indusia; sporangia lacking setae.

Distr. *Malesia*: S.E. Moluccas (Aru Is.: P. Kabroor) and West New Guinea (Waigeu I.: CHEESMAN 1240–1243, BM).

Ecol. On steep limestone which carries little other vegetation.

**48. *Pronephrium acanthocarpum* (COPEL.) HOLTUM**, Blumea 20 (1972) 107. — *Dryopteris acanthocarpa* COPEL. Philip. J. Sci. 6 (1911) Bot. 136, pl. 17. — *Phegopteris acanthocarpa* (COPEL.) v.A.v.R. Handb. Suppl. (1917) 315. — *Thelypteris acanthocarpa* (COPEL.) REED, Phytologia 17 (1968) 257. — Type: BROOKS 54, Sarawak, Mt Penrissen (MICH; BM).

Caudex short-creeping; bases of stipes less than 1 cm apart. *Stipe* to 50 cm long, dark at base with small dark scales and sparse minute hairs, rest glabrous, dull reddish-brown. *Lamina* consisting of one pair of opposite pinnae with a bud at the base of each and an apical section larger than pinnae, the whole dull reddish when dry. *Apical lamina* to  $23 \times 10$  cm, widest near broadly rounded and symmetric base, apex short-acuminate, edges irregularly slightly sinuous; main veins 6 mm apart, at wide angle to midrib, falcate distally; veins more than 20 pairs, not prominent, at a wide angle to main veins, almost all anastomosing with occasional irregularities, excurrent veinlets free; *lower surface* of midrib copiously minutely hairy (less than 0.1 mm), similar hairs sparse on main veins, surface between veins not pustular; *sori* medial or inframedial, those on basal veins sometimes supramedial, in many cases slightly elongate; sporangia bearing several short straight setae; spores not seen. *Pinnae* to  $17 \times 7$  cm; base broadly cuneate and very asymmetric, the basiscopic side 4.5 cm wide at 1/3 length of pinna, acroscopic side 3 cm; veins to 18 pairs on basiscopic side; pubescence and sori as terminal lamina.

Distr. *Malesia*: Borneo (Western Sarawak, two localities; the second is Mt Merinjak).



Ecol. On rocks near streams at 900 m.

**49. *Pronephrium nitidum* HOLTUM**, Blumea 20 (1972) 109. — *Dryopteris urophylla* (METT.) C. CHR. var. *nitida* HOLTUM, Gard. Bull. Str. Settl. 7 (1934) 249, 251 (fig.). — *Thelypteris urophylla* var. *nitida* (HOLTUM) K. IWATS. Acta Phytotax. Geobot. 22 (1966) 94. — Type: HOLTUM SFN 25592, Sabah, Mt Kinabalu, Menetendok (SING; BO, K).

*Cyclosorus urophyllus* sensu COPEL. Fern Fl. Philip. (1960) 373, excl. loc. Malacca. — Fig. 16g-h.

*Caudex* long-creeping, 5–8 mm diameter. *Stipe* commonly 70–100 cm long; base dark with dark rigid scales c. 5 × 1 mm bearing many short stiff hairs, above base brownish to slightly reddish, glabrous. *Lamina* 50 cm long, firm; apex pinna-like, often with almost symmetrical base; pinnae 6–7 pairs, subopposite, lowest pinnae usually with a stalk to 4 mm long, narrowly and asymmetrically cuneate at base, upper pinnae sessile with broader and more symmetric bases (very variable). *Middle pinnae* commonly 20 × 4–5 cm, narrowly elliptic, ± abruptly narrowed to cuneate base and to caudate apex (cauda commonly 2 cm long); edges crenate-serrate with a thick pale cartilaginous margin; costules 3.5–4 mm apart, at a broad angle, falcate distally; veins 18–20 pairs, slender and slightly prominent both sides, very oblique and slightly S-curved, excurrent veinlets almost all free; *lower surface* of rachis and costae covered with pale thin hairs 0.2–0.3 mm long (antrorse but not appressed on costae), similar and sometimes also longer hairs on costules, surface between veins glabrous or with some very short erect hairs, at most slightly pustular; *upper surface* of rachis and costae glabrous or with sparse short hairs, surface between veins smooth and glossy. *Sori* supra-medial, those on connivent veins sometimes ± confluent; receptacle bearing many short acicular hairs with the sporangia; sporangia short-stalked with several acicular hairs on stalks, also 8–12 short acicular hairs distally on body; spores closely and minutely papillose.

Distr. *Malesia*: Banka, Borneo, N. & Central Celebes, Philippines (Sulu Archipelago, Mindanao).

Ecol. At 0–1200 m, usually in secondary forest, often on edges of forest or rather open places on stream-banks.

Note. COPELAND (1960) reports from Palawan, but I have seen no specimen thence. Both sporangia and spores are markedly different from those of *P. repandum*.

**50. *Pronephrium repandum* (FÉE) HOLTUM**, Blumea 20 (1972) 109. — *Goniopteris repanda* FÉE, Gen. Fil. (1852) 251. — Type: GAUDICHAUD, Penang (FI-W, isotype).

*Polypodium cuspidatum* ROXB. Calc. J. Nat. Hist. 4 (1844) 491 (not *Pronephrium cuspidatum*

(BL.) HOLTUM). — Type: WALLICH 299, Penang (BR; K).

*Goniopteris dalhousiana* FÉE, 8e Mém. (1857) 92. — Type: Lady DALHOUSIE, "Indes Orientales" (Herb. Graham, not seen; probable isotype, from Penang, K).

*Phlegopteris urophylla* METT. Farngatt. IV (1858) 26, excl. var. *aspera* (PRESL). — *Polypodium urophyllum* (METT.) HOOK. Spec. Fil. 5 (1863) 9, excl. syn. et var. — *Nephrodium urophyllum* (METT.) KEYSERL. Pol. et Cyath. Herb. Bung. (1873) 49; BEDD. Handb. (1883) 274, p.p. — *Dryopteris urophylla* (METT.) C. CHR. Ind. Fil. (1905) 299, p.p.; v.A.v.R. Handb. (1908) 216, p.p.; BACKER & POSTH. Varenfl. Java (1939) 64, p.p. — *Abacopteris urophylla* (METT.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 8 (1938) 251; HOLTUM, Rev. Fl. Malaya 2 (1955) 296, f. 172. — *Cyclosorus urophyllus* (METT.) TARD. Notul. Syst. 7 (1938) 77; TARD. & C. CHR. Fl. Gén. I.-C. 7, pt. 2 (1941) 391, p.p. — *Thelypteris urophylla* (METT.) K. IWATS. S.E. Asian Studies 3 (1965) 81; Acta Phytotax. Geobot. 22 (1966) 94. — Type: WALLICH 299, Penang (B?; isotype K).

*Polypodium pinwillii* BAK. Ann. Bot. 5 (1891) 460. — *Nephrodium urophyllum* var. *pinwillii* BEDD. Handb. Suppl. (1892) 72. — Type: PINWILL, Malacca (K). — Fig. 1n, 16i-j.

*Caudex* short-creeping, fronds tufted at its apex. *Stipe* to 80 cm long, slightly flushed with red, densely short-hairy with narrow very hairy scales at base, glabrescent above base. *Lamina* to 60 cm long, firm, drying green but rachis, costae and costules ± flushed with red; apex pinna-like with ± asymmetric cuneate base; pinnae 3–6 pairs; lowest pinnae usually slightly smaller than next, always more narrowed at base than the rest, which are very variable in width in relation to length. *Middle pinnae* commonly c. 22 × 4.0 cm, largest 30 × 7 cm, widest at, or more commonly above, the middle, gradually narrowed to a rather abruptly cuneate base, apex abruptly caudate-acuminate, cauda 3–4 cm long; edges ± deeply crenate-serrate with very narrow pale cartilaginous margin; costules 4–5 mm apart, at 45–60°, slightly curved; veins 15–18 pairs, slender, slightly prominent both sides, slightly curved; at 45° to costule, excurrent veinlets often but not always free (if free, extending almost to the junction of the next pair of connivent veins); *lower surface* of rachis and costae ± densely covered with erect pale hairs 0.2–0.3 mm long, similar hairs more sparse on costules, surface between veins finely pustular, bearing a variable number of short erect hairs some of which may be hooked; *upper surface* of rachis and costae hairy as lower surface, rest glabrous, surface between veins minutely pustular. *Sori* medial or supramedial, not elongate, exindusiate; sporangia bearing 10 or more short setae distally, stalk longer than in *P. nitidum* with a hair of

one cell which is in some cases almost spherical; spores with a continuous wing and cross-wings.

Distr. South Thailand & Vietnam, from

Moulmein southwards to *Malesia*: Malaya, Sumatra, Riouw, Lingga & Anambas Is., and West Java.

Ecol. In lowland forest, not in exposed places.

#### 4. Section *Grypothrix*

HOLTUM, *Blumea* 19 (1971) 36.

Type species: *Pronephrium cuspidatum* (BL.) HOLTUM.

Taxon. See discussion under *subg. Menisciopsis*. The earlier-known species of this section were placed in the genus *Meniscium* SCHREB. by SWARTZ, BLUME, PRESL, HOOKER, BEDDOME and RACIBORSKI, and in *Phegopteris* *sect. Meniscium* by METTENIUS and VAN ALDERWERELT. CHRISTENSEN (Monogr. Dryopteris 1, 1913, 248) was the first author to regard them as belonging to a group distinct from the type of *Meniscium*. CHING (1938) clarified the taxonomy and nomenclature of the species of Mainland Asia but did not note the hooked hairs by which these species are distinguished from those here placed in *sect. Menisciopsis*.

*P. triphyllum* is distributed throughout the range of the genus *Pronephrium*; the others are more local in distribution. There are plants which appear to be hybrids of which one parent is *P. triphyllum*. In *Malesia* *P. × parishii* is so designated; there are others, more irregular in frond-form, in Sri Lanka and the Ryukyu Islands. FÉE described a species *Abacopteris elegans* (Gen. Fil. 1852, 310), based on a specimen from Cochinchina which I have not seen; he stated that it had hooked hairs on sporangia, indusiate sori, and excurrent veinlets not free, a combination of characters which I have never seen, and I doubt the accuracy of his observations.

#### KEY TO THE SPECIES

1. Caudex long-creeping with well-spaced fronds.
  2. Pinnae one pair, opposite, always asymmetric . . . . . 51. *P. triphyllum*
  2. Pinnae 2–6 pairs, distal ones small and adnate, rest with variable asymmetry . . . . . 52. *P. × parishii*
1. Caudex short-creeping, fronds close together.
  3. Pinnae all narrowly cuneate at base, fertile ones commonly 1 cm wide; hooked hairs lacking on lamina and sporangia . . . . . 53. *P. salicifolium*
  3. Pinnae not all narrowly cuneate at base, fertile ones always much more than 1 cm wide; hooked hairs present on some parts of lamina and usually on sporangia.
    4. Pinnae 1–3 pairs; no buds at their bases.
      5. Pinnae always opposite; fertile pinnae with undulate margins; hooked hairs present on basal scales and on sporangia . . . . . 54. *P. rubicundum*
      5. Pinnae not always opposite; fertile pinnae sharply serrate-crenate distally; no hooked hairs on scales nor on sporangia . . . . . 55. *P. sulawesense*
    4. Pinnae of well-grown plants more than 3 pairs; a bud always present at base of uppermost pinna.
      6. Bud confined to base of uppermost pinna; pinnae widest in basal half; hydathodes on upper surface conspicuous . . . . . 56. *P. cuspidatum*
      6. Buds present at bases of several pinnae; pinnae usually widest above middle; hydathodes not conspicuous . . . . . 57. *P. ramosii*
  7. Hooked hairs present on sporangia . . . . . 57a. *P. ramosii* var. *ramosii*
  7. Hooked hairs lacking on sporangia . . . . . 57b. *P. ramosii* var. *minahassae*

51. *Pronephrium triphyllum* (Sw.) HOLTUM, *Blumea* 20 (1972) 122; *Allertonia* 1 (1977) 214; BROWNIE, Pterid. Fiji (1977) 257. — *Meniscium triphyllum* Sw. in Schrad. J. Bot. 1800, 2 (1801) 16; HOOK. & GREV. Ic. Fil. (1820) t. 120; BEDD. Ferns S. India (1863) t. 56; Handb. (1883) 397; RACIB. Fl. Btzig 1 (1898) 66. — *Phegopteris triphylla* (Sw.) METT. Fil. Lechl. (1859) 21; v.A.v.R. Handb. (1908) 509. — *Dryopteris triphylla* (Sw.) C. CHR. Ind. Fil. (1905) 298; BACKER & POSTH. Varenfl. Java (1939) 59. — *Abacopteris*

*triphylla* (Sw.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 8 (1938) 241; HOLTUM, Rev. Fl. Malaya 2 (1955) 287, f. 166. — *Cyclosorus triphyllus* (Sw.) TARD. Notul. Syst. 7 (1938) 78; TARD. & C. CHR. Fl. Gén. 1.-C. 7, pt. 2 (1941) 386; COPEL. Fern Fl. Philip. (1960) 371. — *Thelypteris triphylla* (Sw.) K. IWATS. Mem. Coll. Sci. Univ. Kyoto B, 31 (1965) 190. — Type: China (S-PA).

*Meniscium cumingii* FÉE, Gen. Fil. (1852) 222. — Type: CUMING s.n., Philippines (not seen). — Fig. 16k-l.

*Caudex* long-creeping, 2–3 mm diameter, covered with short pale hooked hairs; scales c. 3 mm long, narrow, bearing many short straight hairs. *Stipe* of sterile fronds 7–20 cm long, of fertile 20–50 cm, ± tinged with dull red, rather sparsely hairy, hairs as caudex. *Lamina* consisting of an apical section and one pair of opposite pinnae attached 0.5–2.0 cm below it. *Sterile apical lamina* 10–18 cm long, 2.5–4.0 cm wide; base almost symmetrical, broadly cuneate to rounded, rarely somewhat cordate; apex short-acuminate; edges entire or slightly sinuous; main veins 4–4.5 mm apart along midrib; veins 10–12 pairs, pale, slender, slightly prominent on lower surface, at a broad angle to main veins, excurrent veinlets free or meeting the junction of the next pair of connivent veins; lower surface of midrib and main veins bearing pale hooked hairs 0.3–0.4 mm long, rest of surface glabrous, or with a few short erect hooked hairs, slightly pustular between veins; upper surface of midrib bearing copious short hooked hairs, hairs on main veins sparse. *Fertile apical lamina* 1.0–2.5 cm wide; veins to 7 pairs, almost at right angles to main veins; excurrent veinlets almost always short and free; sori extending all along each vein so that sporangia are distributed in a crescent-shaped row along each pair of connivent veins; sporangia bearing hooked hairs distally and sometimes a hair of 2 cells on the stalk; spores bearing many separate but not crowded small wings. *Sterile pinnae* 5–10 cm long, 1.5–3.0 cm wide, with stalks 1–3 mm long, shaped as apical lamina but asymmetric, the lamina wider on basiscopic side of costa than on acroscopic; veins to c. 8 pairs on basiscopic side. *Fertile pinnae* 1.0–2.5 cm wide, sori as apical lamina.

*Distr.* Tropical and subtropical mainland S.E. Asia, Taiwan, Ryukyu Islands; throughout *Malasia*; N. Queensland, Fiji (only 1 record from Fiji).

*Ecol.* Low altitudes in light shade, sometimes abundant under fruit trees or palms in villages; few collections from Philippines and New Guinea.

**52. *Pronephrium* × *parishii* (BEDD.) HOLTUM**, *Blumea* 20 (1972) 123. — *Meniscium parishii* BEDD. *Ferns Brit. India* (1866) t. 184. — *Meniscium triphyllum* var. *parishii* BEDD. *Handb.* (1883) 399. — *Abacopteris triphylla* var. *parishii* (BEDD.) CHING, *Bull. Fan Mem. Inst. Biol. Bot.* 8 (1938) 241; HOLTUM, *Rev. Fl. Malaya* 2 (1955) 287. — *Thelypteris triphylla* var. *parishii* (BEDD.) K. IWATS. *Mem. Coll. Sci. Univ. Kyoto B*, 31 (1965) 191. — *Thelypteris parishii* (BEDD.) PANIGRAHI, *Phytologia* 31 (1975) 372. — *Type:* PARISH 135, Burma, Moulmein (K).

*Caudex* long-creeping, to 4 mm diameter, as *P. triphyllum* in hairs and scales (hairs on scales of some Indian specimens not hooked). *Lamina* variable; *apical section* about as in *P. triphyllum* but often with 1 or 2 narrow lobes at the base, or

1–2 small narrow adnate free pinnae just below it, no buds at the bases of upper pinnae; *pinnae* to 6 pairs, usually opposite but sometimes not, usually increasing in size from apex to base of frond, upper ones always ± adnate to rachis at basiscopic base; largest 15 × 2–3 cm, sometimes with lamina symmetrically divided by the costa, sometimes the two halves unequal in width as in *P. triphyllum*; pubescence as in *P. triphyllum* but more numerous erect hooked hairs often present on lower surface between veins. *Sori* as in *P. triphyllum*; sporangia sometimes with longer hooked hairs; spores not seen.

*Distr.* Assam, Burma, Thailand, Vietnam; in *Malasia*: Malaya (Perak and Pahang).

*Ecol.* In Malaya along stream banks in rather open forest, at low altitudes.

*Notes.* The specimens referred here are variable, and in their small adnate upper pinnae agree with *Meniscium thwaitesii* HOOK. of Ceylon, but the pinnae of the latter are more irregular and some of its hairs are not hooked. Variability among the present specimens suggests hybridity, one parent certainly being *P. triphyllum*; it is possible that plants in different areas have different genetic origins.

**53. *Pronephrium salicifolium* (WALL. ex HOOK.) HOLTUM**, *Blumea* 20 (1972) 123. — *Meniscium salicifolium* WALL. ex HOOK. *IC. Pl.* 10 (1854) t. 990; BEDD. *Ferns Brit. India* (1866) t. 207; *Handb.* (1883) 399. — *Phegopteris salicifolia* (WALL. ex HOOK.) METT. *Fil. Lechl.* 2 (1859) 22; v.A.v.R. *Handb.* (1908) 511. — *Abacopteris salicifolia* (WALL. ex HOOK.) HOLTUM, *Rev. Fl. Malaya* 2 (1955) 288, f. 167. — *Thelypteris salicifolia* (WALL. ex HOOK.) REED, *Phytologia* 17 (1968) 311. — *Type:* WALLICH 63, Penang (K).

*Caudex* short-creeping, 7–8 mm diameter, bearing sparse hooked hairs. *Stipe* 20–60 cm long; near base a few hooked hairs and rigid dark scales to 10 × 1 mm bearing pale hooked hairs, rest of stipe glabrous, glossy, ± castaneous. *Lamina* 30–80 cm long, very firm, somewhat dimorphous, slightly flushed with red when dry; apex pinna-like, not or little larger than distal pinnae; *pinnae* to 18 pairs, a bud sometimes present at base of uppermost pinna; basal pinnae asymmetric at base, the blade decurrent to the attachment to rachis on acroscopic side, ending 5 mm or more from rachis on basiscopic side. *Middle pinnae* commonly 10–15 cm long, fertile ones 0.6–1.2 cm wide, sterile sometimes wider, largest sterile pinnae 20 × 2.5 cm, fertile rarely to 2 cm wide; base always very narrowly cuneate; apex narrowly acuminate but not caudate; edges quite entire; costules 3–4 mm apart, at 45° to costa; veins 3–10 pairs (according to width of pinna), almost all anastomosing, not prominent on either side, excurrent veins all free except distal ones; *both surfaces* quite glabrous. *Sori* supramedial, elongate along

veins, those on connivent veins usually meeting; no hairs on body of sporangia and none seen on stalk; spores with a  $\pm$  continuous wing and cross-wings.

Distr. *Malesia*: Malaya, Sumatra, Borneo.

Ecol. On rocks in and beside streams, in forest, in flood zone, at 0–500 m; plants in the more exposed places on rocks in a stream-bed have smallish fronds with narrow pinnae. The very firm narrow pinnae are probably an adaptation to dry conditions when the stream is low and also to survival in the periodic rush of flood-water; in form they closely resemble the pinnae of *Dipteris lobbiana* (HOOK.) MOORE, which grows in similar habitats.

**54. *Pronephrium rubicundum*** (v.A.v.R.) HOLTUM, *Blumea* 20 (1972) 123. — *Phegopteris rubicunda* v.A.v.R. *Bull. Jard. Bot. Btzig III*, 2 (1920) 162. — *Abacopteris rubicunda* (v.A.v.R.) HOLTUM, *Rev. Fl. Malaya* 2 (1955) 292, f. 170. — *Thelypteris rubicunda* (v.A.v.R.) K. IWATS. *Mem. Coll. Sci. Univ. Kyoto B*, 31 (1965) 195. — Type: BROOKS 232/S, Sumatra, Lebong Tandai (BO; BM). — **Fig. 10, 16a–d.**

*Caudex* short-creeping, to 8 mm diameter, bearing hooked hairs. *Young plants* bearing simple fronds up to 30 × 12 cm, sometimes with fertile ones 20 × 5 cm; later fronds on these plants having lateral pinnae, the apical lamina progressively smaller. *Stipe* 20–30 cm long on sterile fronds, to 70 cm on largest fertile ones, base bearing thin narrow scales to c. 8 × 1 mm with a variable number of hooked hairs on them, above base  $\pm$  flushed with dull red and bearing sparse pale short hooked hairs. *Lamina* 20–35 cm long, firm, drying dull reddish, consisting of an apical segment and 1–3 pairs of opposite pinnae; no buds at bases of pinnae; all pinnae asymmetric, broader on basiscopic side of costa than on acroscopic; basal pinnae short-stalked. *Apical lamina* of fronds with 3 pairs of pinnae 15–20 × 5–8 cm (proportion of length to width very variable), base broadly rounded to broadly cuneate, apex short-acuminate, edges entire to rather strongly undulate. *Largest pinnae* usually at a wide angle to rachis, 10–24 × 3–7 cm, widest about the middle or sometimes above the middle, base cuneate to rounded, apex abruptly caudate (cauda commonly to 2 cm long), edges entire (sterile) or undulate (most fertile ones); costules 3.5 mm apart (fertile) or 4.5 mm (sterile); veins 12–15 pairs, slightly prominent on lower surface, where sterile at 45° to costules, where fertile closer and almost at right angles to costules, excurrent veinlets all free; *lower surface* of rachis and costae sparsely to rather copiously hairy, most abundantly on young plants, hairs all hooked, similar hairs sometimes present on surface between veins; *upper surface* of rachis and costae bearing  $\pm$  abundant pale hooked hairs less

than 0.5 mm long. *Sori* medial,  $\pm$  elongate, those on connivent veins often uniting; sporangia usually with 2 hooked hairs distally, hairs on stalk not seen; spores with rather narrow wing and a few cross-wings.

Distr. Peninsular Thailand, in *Malesia*: Sumatra, Malaya.

Ecol. In primary forest at 0–800 m, not on stream-banks.

**55. *Pronephrium sulawesiense*** (K. IWATS.) HOLTUM, *sp. nov.* — *P. rubicundum* ssp. *sulawesiense* K. IWATS. *Acta Phytotax. Geobot.* 28 (1977) 162, f. 2. — Type: K. SOMA *et al.* 218, 249, Central Celebes, inland from Polo, Kelawi Distr. 1000–1700 m (TUS, not seen).

Differs from *P. rubicundum* as follows: *scales* on rhizome 4 × 2.5 mm, on stipe 5 × 1.8 mm, lacking hooked hairs; *pinnae* not always opposite, to 24 × 4.5 cm including apical cauda 4 cm long, more oblique to rachis, distal ones longest, apparently almost symmetric in shape, widest 1/3 from apex, edges of fertile pinnae strongly crenate-serrate distally, of sterile ones less strongly; *sori* medial, those on connivent veins not meeting; sporangia lacking hooked hairs.

Distr. *Malesia*: Central Celebes, only known from the type.

Notes. This is geographically remote from *P. rubicundum* and differs in scales, proportionately narrower more oblique more symmetrical pinnae with different edges. The figure shows a fertile frond with distinctly alternate pinnae. In frond-form this is nearer to *P. ramosii* of the Philippines but differs in other characters.

**56. *Pronephrium cuspidatum*** (BL.) HOLTUM, *Blumea* 20 (1972) 123, *excl. syn. praeter Bl.* — *Meniscium cuspidatum* BL. *En. Pl. Jav.* (1828) 114; *Fl. Jav. Fil.* (1828) 102, t. 45; *RACIB. Fl. Btzig* 1 (1898) 65. — *Phegopteris cuspidata* (BL.) METT. *Farngett. IV* (1858) 25; v.A.v.R. *Handb.* (1908) 511. — *Dryopteris cuspidata* (BL.) CHRIST, *Philip. J. Sci.* 2 (1907) Bot. 205, p.p.; BACKER & POSTH. *Varenfl. Java* (1939) 63, f. 10. — *Abacopteris cuspidata* (BL.) CHING, *Bull. Fan Mem. Inst. Biol. Bot.* 8 (1938) 245. — *Cyclosorus cuspidatus* (BL.) COPEL. *Gen. Fil.* (1947) 142; *Fern Fl. Philip.* (1960) 375, *nomen tantum.* — *Thelypteris cuspidata* (BL.) K. IWATS. *Mem. Coll. Sci. Univ. Kyoto B*, 31 (1965) 192. — Type: BLUME, Java (L).

*Dryopteris amaiensis* ROSENST. *Meded. Rijksherb. n.* 31 (1917) 6. — Type: HALLIER 3157, Java (L).

*Caudex* short-creeping, 7–10 mm diameter, bearing hooked hairs. *Stipe* to 50 cm or more long, dark at base with sparse hooked hairs and firm dark brown scales c. 10 × 1 mm bearing a few hooked hairs, above base light-castaneous, glabrous. *Lamina* commonly 30–50 cm long (to

120 cm, *fide* BACKER & POSTHUMUS), firm, drying dull reddish; apical segment of similar size to upper pinnae, base cuneate and slightly asymmetric; pinnae commonly to 6 pairs (10 pairs on type), lowest usually opposite, the rest often not so, a bud always at base of highest pinna only of old fronds; basal pinnae with stalks to 5 mm long, slightly asymmetric on either side of costa, otherwise like the rest. *Pinnae* commonly to  $16 \times 3.5$  cm, sometimes dimorphous, smallest fertile ones  $9 \times 2$  cm, largest sterile  $20 \times 6$  cm, symmetric on either side of costa, usually widest  $1/4-1/3$  from base, base narrowly to broadly cuneate, slightly asymmetric with the acroscopic edge decurrent to junction with rachis, the basiscopic edge less decurrent; apex caudate-acuminate to abruptly cuspidate (narrow tip 1.5–2.5 cm long); edges entire or nearly so; costules 3.5–4 mm apart, at  $45^\circ$  to costa, grooved above when dry and slightly prominent beneath; veins 10–12 pairs, not prominent either side, dark on lower surface, at a narrower angle to costules in sterile than in fertile fronds, excurrent veinlets mostly free and ending in a conspicuous hydathode on upper surface (with white incrustation on old fronds); lower surface glabrous throughout or (especially in Sumatra) with a few hooked hairs on costae and costules; upper surface quite glabrous, even in groove of rachis. *Sori* near costules, somewhat elongate, those on connivent veins near costa uniting, distal ones sometimes not; sporangia lacking hooked hairs on Java specimens, such hairs present on specimens from Sumatra.

Distr. *Malesia*: Sumatra, Borneo, Java and Lesser Sunda Is. (Flores).

Ecol. On rocks or steep valley-sides in forest at altitudes to 1200 m.

Note. There may be some introgressive hybridization between this species and *P. rubicundum* in Sumatra.

**57. *Pronephrium ramosii* (CHRIST) HOLTUM, comb. nov.** — *Dryopteris ramosii* CHRIST, Philip. J. Sci. 2 (1907) Bot. 203. — Lectotype (selected

here): RAMOS BS 1792, Luzon, Rizal Prov. (P; FI, K).

*Cyclosorus cuspidatus sensu* COPEL. Fern Fl. Philip. (1960) 375, excl. syn. *Meniscium cuspidatum* BL. — Fig. 16e–f.

**a. var. *ramosii*.**

Differs from *P. cuspidatum* as follows: *scales* at base of stipe to  $4 \times 1$  mm, lacking hooked hairs; *pinnae* always alternate, including basal ones, in almost all cases widest above the middle and narrowly cuneate at base (exceptions are specimens from Mindoro and Sibuyan, commonly c.  $11 \times 2.5$  cm, *buds* present at the bases of several pinnae (to 4 on each side of rachis); *veins* 6–8 pairs, no conspicuous hydathodes present at apices of excurrent veinlets; *hooked hairs* usually more abundant on lower surface of costae and costules, often present between veins on lower surface, present also in groove of upper surface of costae and in groove of rachis at base of a costa; *sori* medial; sporangia always bearing hooked hairs.

Distr. *Malesia*: Philippines (Luzon to Mindanao), Moluccas (Halmahera), N.E. New Guinea.

Ecol. "Common at 600–800 m along streams in damp gulches" (COPELAND).

**b. var. *minahassae* HOLTUM, var. nov.**

A var. *ramosii* differt: *pinnis* usque  $23 \times 4$  cm (*steriles*),  $18 \times 3.5$  cm (*fertiles*); *pilis hamatis sub-ter venas carentibus*; *sporangii pilis hamatis non praeditis*. — Type: ALSTON 16551, N. Celebes, G. Manembo-nembo (BM).

Distr. *Malesia*: N. Celebes.

Note. *Meniscium liukuense* CHRIST, which I listed in the synonymy of *P. cuspidatum* in 1972, should also be included in *P. ramosii*, perhaps as a distinct variety; its excurrent veins are mostly not free. In the Solomon Islands is another possibly distinct variety which has no hooked hairs on sporangia and lower surface; they occur only at the base of costae on the upper surface.

## 19. NANNOTHELYPTERIS

HOLTUM, *Blumea* 19 (1971) 38; *Kalikasan* 2 (1973) 64. — Fig. 17.

*Caudex* short-creeping; fronds somewhat dimorphous, sterile ones with shorter stipes and larger pinnae than fertile; pinnae 16–35 pairs, not more than 2.5 cm long, close together except in some fertile fronds, lower pinnae more widely spaced but hardly reduced; veins free or the basal ones anastomosing; lower surface of pinnae between veins  $\pm$  pustular when dry, not glandular, in some cases with minute acicular hairs; upper surface between veins glabrous or with minute erect acicular hairs; sori indusiate or exindusiate; indusia bearing hairs or glands; sporangia bearing spherical

yellow glands, as in *Sphaerostephanos*; spores with a  $\pm$  complete wing and some cross-wings.

Type species: *Nannothelypteris aoristisora* (HARR.) HOLTUM.

Distr. *Malesia*: Philippines (Luzon, Panay, Samar, Mindanao).

Ecol. In forest, in some cases on rocks.

Cytol.  $n = 36$  (M. G. PRICE, *N. camarinensis*).

Taxon. A natural group of species closely related to *Pronephrium* sect. *Dimorphopteris*, with which it might be united. No transference is here made to *Pronephrium* because of the uncertain status of the latter.

COPELAND's treatment of these species in his Fern Flora of the Philippines is confused because he did not examine details. Some earlier confusion was caused by the inclusion by CUMING of some specimens of *Sphaerostephanos lastreoides* in his n. 251, together with the type collection of *Nannothelypteris philippina*.

#### KEY TO THE SPECIES

1. One pair of veins regularly anastomosing, at least near bases of larger pinnae; short hairs present between veins on upper surface.
  2. Sori exindusiate; pinnae less than 2 cm long . . . . . **1. *N. aoristisora***
  2. Sori indusiate; pinnae to 3 cm long . . . . . **2. *N. camarinensis***
1. Veins all free, or with casual slight anastomosis; upper surface between veins glabrous, or nearly so.
  3. Pinnae to 1.3 cm long, almost entire; costules mostly forked, the branches of adjacent ones sometimes anastomosing . . . . . **3. *N. nervosa***
  3. Pinnae (at least sterile ones) to 2 cm or more long, distinctly lobed at least on acroscopic side; veins all free.
    4. Sterile pinnae to  $2.5 \times 1.0$  cm, lobed equally both sides half-way to costa or more deeply, not conspicuously auricled; indusia setose . . . . . **4. *N. philippina***
    4. Sterile pinnae usually not over 2 cm long, 5–6 mm wide above the auricled base, lobed more deeply on acroscopic than on basiscopic side; indusia glandular . . . . . **5. *N. inaequilobata***

**1. *Nannothelypteris aoristisora*** (HARR.) HOLTUM, Blumea 19 (1971) 38; Kalikasan 2 (1973) 65. — *Polypodium aoristorum* HARR. J. Linn. Soc. Bot. 16 (1897) 30. — *Phegopteris aoristisora* (HARR.) v.A.v.R. Handb. (1908) 501. — *Cyclosorus aoristorum* (HARR.) COPEL. Gen. Fil. (1947) 142; Fern Fl. Philip. (1960) 355, p.p. — *Thelypteris aoristisora* (HARR.) REED, Phytologia 17 (1968) 260. — Type: STEERE, Panay (MICH; K).

Stipe 3–12 cm long (longest in fertile fronds), short-hairy; lamina to 20 cm long; pinnae to 25 pairs. Sterile pinnae to  $1.7 \times 0.6$  cm; base slightly to distinctly auricled on acroscopic side, rounded on basiscopic; apex obtusely pointed to rounded; edges crenate to lobed, more deeply on acroscopic than on basiscopic side; costules 2.5 mm apart; veins 2–3 pairs, basal pair anastomosing except near apex of pinna; lower surface of rachis densely short-hairy, hairs more sparse on costules and veins; upper surface of rachis with thicker and more sparse hairs, surface of pinnae between veins bearing scattered very short erect hairs. Fertile pinnae  $1.1 \times 0.35$  cm; sori at maturity filling lower surface, exindusiate.

Distr. *Malesia*: Philippines (Panay; Luzon: Mt Makiling).

**2. *Nannothelypteris camarinensis*** HOLTUM, Kal-

ikasan 5 (1976) 119. — Type: M. G. PRICE 3101, Luzon, Camarines Norte, Basud, Cone Mt (PNH; K). — Fig. 17e–f.

Sterile fronds of young plants: stipe 3–6 cm long; lamina 15 cm long with 10–16 pairs of pinnae; pinnae to 2.0 cm long, 0.4 cm wide above a rounded basiscopic auricle, edges subentire, apex rounded. Larger fronds, partially fertile: stipe 5–10 cm long; pinnae to  $2.5 \times 0.7$  cm, basal auricles smaller; apex more narrowly obtuse; edges strongly crenate; costules 3 mm apart at  $45^\circ$  to costa; veins to 4 pairs, basal pair anastomosing; lower surface of rachis bearing copious pale hairs 0.3 mm long, shorter hairs on costae with scattered thick ones 0.5 mm long, minute hairs on surface between veins; upper surface of rachis with more sparse and thicker hairs, whole surface of pinna bearing abundant short erect hairs. Fully fertile fronds: stipe slender, to 22 cm long; pinnae to  $1.5 \times 0.5$  cm; sori medial, slightly elongate on the veins, with short-hairy indusia and glandular sporangia.

Distr. *Malesia*: Philippines (Luzon), only known from the type.

Ecol. On forested rocky slope at 250–350 m.

**3. *Nannothelypteris nervosa*** (FÉE) HOLTUM, Kalikasan 2 (1973) 66. — *Phegopteris nervosa* FÉE, Gen. Fil. (1852) 244; 6e Mém. (1853) 13, t. 2,

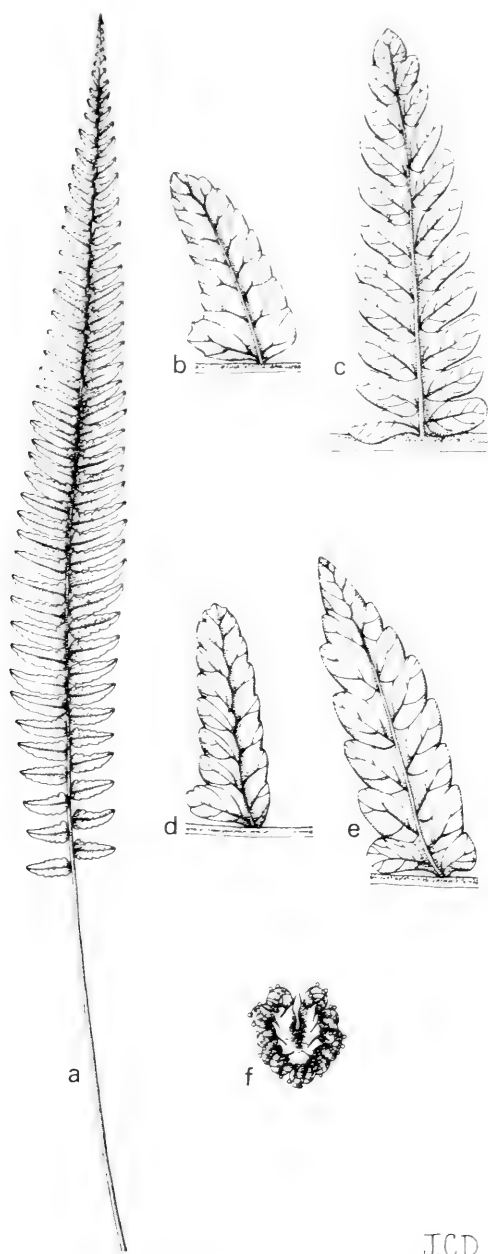


Fig. 17. *Nannothypteris nervosa* (FÉE) HOLTUM. a. Frond,  $\times \frac{1}{2}$ ; b. pinna,  $\times 3$ . — *N. philippina* (PR.) HOLTUM. c. Pinna,  $\times 2$ . — *N. inaequilobata* HOLTUM. d. Sterile pinna,  $\times 2$ . — *N. camarinensis* HOLTUM. e. Pinna,  $\times 2$ ; f. sorus,  $\times 24$  (a–b PRICE & HERNAEZ 71, c isotype K, d holotype, e–f holotype).

f. 4. — *Aspidium exiguum* KUNZE ex METT. Farngatt. IV (1858) 76, var. a. — *Lastrea nervosa* (FÉE) COPEL. Philip. J. Sci. 81 (1952) 32; Fern Fl. Philip. (1960) 323, nomen tantum. — Type: CUMING s.n., Philippines (FÉE's specimen not seen; specimens at B, BM, G, K agree with FÉE's figure and are perhaps isotypes).

*Polystichum auriculatum* var. *nervosum* CHRIST, Bull. Herb. Boiss. 6 (1898) 192; v.A.v.R. Handb. (1908) 165.

*Cyclosorus aoristisorus* sensu COPEL. Fern. Fl. Philip. (1960) 355, p.p. — Fig. 17a–b.

Fronds almost uniform, but stipe of sterile ones 7–10 cm long, fertile 15 cm. Lamina to 24 cm long; pinnae 30–40 pairs. Largest pinnae 1.3 cm long, 3–3.5 mm wide above the dilated base which is 4–4.5 mm wide (base more auricled on acroscopic side in fertile than in sterile pinnae); apex obtuse; edges entire or slightly crenate distally; costules 1.5 mm apart, simply forked or with one branch forked again, in basal acroscopic lobe pinnate with 2–3 pairs of veins; veins free or with casual anastomosis; lower surface of rachis densely short-hairy, hairs sparse on costae and costules; upper surface of rachis with more sparse and shorter hairs than lower, sparse minute hairs on costae. Sori near margins of pinnae, on acroscopic branch of each costule; indusia small, hairy.

Distr. *Malesia*: Philippines (Mindanao, Samar), at low altitudes.

Notes. The name *Lastrea exigua* J. SM., on which *Aspidium exiguum* KUNZE ex METT. was based, was published (without description) with citation of CUMING 251 and 272, types of *N. philippina* and *N. inaequilobata*; Mettenius cited *P. nervosa* FÉE under his var. a. If transferred to *Thelypteris*, *N. nervosa* will need another specific epithet, as *T. nervosa* (KLOTZSCH) TRYON represents another species.

4. *Nannothypteris philippina* (PRESL) HOLTUM, Kalikasan 2 (1973) 66. — *Physematum philippinum* PRESL, Epim. Bot. (1851) 192; HOLTUM, Novit. Bot. Univ. Carol. Prag. 1968 (1969) 44, excl. syn. *Phlegopteris nervosa* FÉE. — *Thelypteris philippina* (PRESL) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 283. — Type: CUMING 251, Luzon, S. Ilocos (PRC; G, K, P, US).

*Dryopteris confusa* COPEL. Philip. J. Sci. 8 (1911) Bot. 146. — *Lastrea confusa* COPEL. Fern Fl. Philip. (1960) 324. — *Thelypteris confusa* (COPEL.) REED, Phytologia 17 (1968) 268. — Type: CUMING 251 partim (M, destroyed); neotype (HOLTUM 1973): RAMOS BS 8271 (MICH; US).

*Aspidium exiguum* KUNZE ex METT. Farngatt. IV (1858) 76, var. b, p.p. — *Dryopteris exigua* sensu v.A.v.R. Handb. (1908) 190. — Fig. 17c.

Fertile and sterile fronds almost alike. Stipe c. 20 cm long, pale, copiously short-hairy. Lamina to

J.C.D.

30 cm long; pinnae to 20 pairs, lower ones more widely spaced and slightly reduced. *Largest pinnae* 2.5 × 1.0 cm, gradually narrowed from truncate base to abruptly obtuse or rounded apex, lobed equally on both sides 1/3–1/2 towards costa; lobes oblique, basal acroscopic one often slightly enlarged; costules 2.5–3 mm apart; veins 3–4 pairs, basal acroscopic one ending at base of sinus, basiscopic one passing to margin above base of sinus; *lower surface* of rachis bearing coarse pale hairs 0.3–0.5 mm long, hairs on costae very short with a few longer ones, sparse on costules; *upper surface* of rachis as lower, hairs on costae minute. *Sori* inframedial; indusia small, setiferous; sporangia bearing glands.

Distr. *Malesia*: Philippines (Luzon).

Note. In some herbaria specimens of CUMING 251 and 272 are mounted without distinction on the same sheet. The number 251 here refers to the specimens at Prague and elsewhere as indicated, but at BM the specimen of the present species bears the number 272.

5. *Nannothelypteris inaequilobata* HOLTUM, *Kalikasan* 2 (1973) 67. — *N. nervosa* *sensu* HOLTUM, *Blumea* 19 (1971) 38, *p.p.* — Type:

CUMING 272, Luzon (K; B, E, G, L, P).

*Aspidium exiguum* KUNZE *ex* METT. *Farngett.* IV (1858) 76, *var. b*, *p.p.* — Fig. 17d.

Fronds distinctly dimorphous; pubescence as *N. philippina*. *Sterile fronds*: stipe 5–9 cm long; lamina to 20 cm long, pinnae 25 pairs or more, lower 3–4 pairs not reduced but more widely spaced, lowest with free basal acroscopic lobe; *largest pinnae* 1.5–2.0 cm long, 0.5–0.6 cm wide above base, base rather narrowly rounded, on basiscopic side, auricled on acroscopic, basiscopic margin slightly crenate distally, acroscopic margin deeply crenate; costules 2 mm apart, very oblique, veins 2 pairs (3–4 pairs on basal auricle), basal acroscopic vein ending at base of sinus. *Fertile fronds*: stipe to 15 cm long; lamina 20–30 cm long, pinnae to 30 pairs, lower ones more widely spaced than in sterile fronds; *largest pinnae* 1.0–1.3 cm long, to 0.4 mm wide above base, on acroscopic side lobed 1/2 way to costa, costules less than 2 mm apart; *sori* inframedial, indusia bearing glands, not hairs.

Distr. *Malesia*: Philippines (Luzon: Mt Makiling and Nueva Vizcaya Province).

Ecol. On Mt Makiling at 300 m, near mud-springs in open place in forest.

## 20. STEGNOGRAMMA

BLUME, *En. Pl. Jav.* (1828) 172; CHING, *Sinensia* 7 (1936) 90; *Acta Phytotax. Sinica* 8 (1963) 329; COPEL. *Gen. Fil.* (1947) 144; K. IWATS. *Acta Phytotax. Geobot.* 19 (1963) 112; *Mem. Coll. Sci. Univ. Kyoto B*, 31 (1964) 18–21; *Amer. Fern J.* 54 (1964) 141; HOLTUM, *Blumea* 19 (1971) 38. — *Leptogramma* J. SM. in Hook. *J. Bot.* 4 (1841) 51; *Hist. Fil.* (1875) 231; CHING, *Sinensia* 7 (1936) 96. — Fig. 18.

*Caudex* short-creeping or erect; stipes densely hairy, hairs unicellular (pluricellular in *sect. Haplogramma*, not Malesian); scales bearing unicellular acicular hairs on edges and surface; fronds simply pinnate; apical lamina always deltoid and deeply lobed with basal basiscopic veins of some of the middle or lower lobes springing directly from the rachis; pinnae subentire to deeply lobed, upper ones always ± adnate to rachis, in some species only the lowest fully free; lowest pinnae not or little reduced; spherical glands lacking; hairs between veins on upper surface few, rather long, not appressed; veins free or anastomosing; sori exindusiate, extending along the veins (where veins anastomose, sori also along the intermediate excurrent veins between costules); sporangia setiferous; spores with many small wings.

Type species: *Stegnoگرامma aspidioides* BL.

Distr. Pantropic (excluding New Guinea and the Pacific) and subtropic, c. 18 spp.; in *Malesia* on mountains in Sumatra, Java, Borneo, Celebes, Luzon, Mindanao.

Cytol. Chromosome number 36 in *sect. Leptogramma* (diploid in Mexico, Ceylon and Japan; tetraploid in Madeira); in other sections unknown.

Taxon. IWATSUKI's arrangement of 1963 is here adopted. In it he recognized four sections, two of



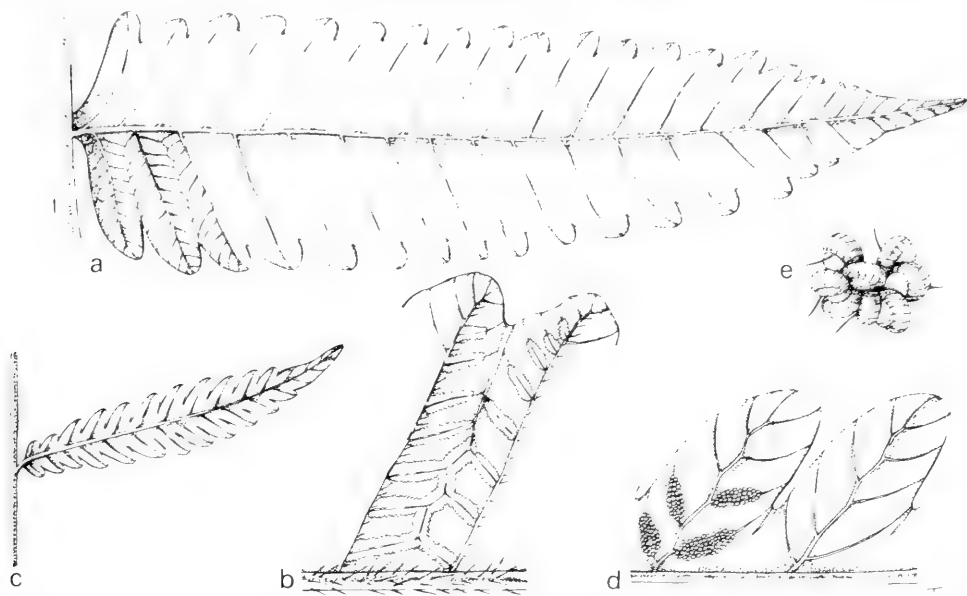


Fig. 18. *Stegnogramma aspidioides* BL. a. Pinna,  $\times 1$ ; b. part of fertile pinna showing extent of sori,  $\times 3$ . — *S. subcalcarata* (v.A.v.R.) HOLTUM. c. Pinna,  $\times 1$ ; d. venation and sori,  $\times 6$ ; e. part of sorus,  $\times 24$  (a–b T. LOBB s.n., c–e isotype K).

which (*Haplogramma* and *Dictyocline*) do not occur in Malesia. The New World species (see IWATSUKI 1964) are not yet well studied. In Malesia, the widely-distributed species *S. pozoi* is represented by a variety in Java; the other plants of sect. *Leptogramma*, from four widely-separated small areas, are here regarded as representing separate species, but more material is needed to characterize them clearly; only *S. dissitifolia* has been well collected.

*Stegnogramma* is related to those species of *Sphaerostephanos* which have no spherical glands, but is distinct in the combination of characters mentioned in the generic description. In the 19th century, species of this genus were usually placed in *Gymnogramme*.

The peculiar Hawaiian species *Pneumatopteris sandwicensis* (BRACK.) HOLTUM shares with *Stegnogramma* the characters of venation of the apical lamina and few thick hairs between veins on the upper surface of pinnae, and has somewhat elongate sori, but differs in sporangia and spores.

#### KEY TO THE SPECIES

1. Veins anastomosing (sect. *Stegnogramma*) . . . . . 1. *S. aspidioides*
1. Veins free (sect. *Leptogramma*).
2. Pinnae to  $7.5 \times 1.6$  cm or larger; lower surface of costae bearing many hairs, short ones more abundant than longer . . . . . 2. *S. pozoi* var. *petiolata*
2. Pinnae, if over 4 cm long, not more than 1 cm wide; lower surface of costae bearing rather sparse hairs 0.5 mm or more long and a few short ones.
3. Pinnae not over 1.5 cm long, only basal ones lobed; sporangia sparsely setose . . . . . 3. *S. gymnocarpa*
3. Pinnae longer, several pairs lobed; sporangia all freely setose.
4. Pinnae to  $5.0 \times 0.8$  cm with narrowly triangular apex 10 mm long . . . . . 4. *S. subcalcarata*
4. Pinnae proportionately wider with short entire apex.
5. Fronds to 30 cm long; basal pinnae lobed more than half-way towards costa . . . . . 5. *S. dissitifolia*
5. Fronds c. 16 cm long; basal pinnae less deeply lobed . . . . . 6. *S. celebica*

1. *Stegnogramma aspidioides* BL. En. Pl. Jav. (1828) 173. — *Gymnogramme stegnogramma* BL. Fl. Jav. Fil. (1829) 98, t. 44. — *Gymnogramme aspidioides* HOOK. Gen. Fil. (1841) t. 120B non

KAULF. 1824 nec DESV. 1827 nec BL. 1828; Ic. Pl. 10 (1854) t. 950; Spec. Fil. 5 (1864) 150, excl. pl. Khasya & Ceylon; RACIB. Fl. Btjg 1 (1898) 70. — *Phegopteris stegnogramma* METT. Fil. Hort. Lips.

(1856) 84; v.A.v.R. Handb. (1908) 508. — *Dryopteris stegnogramma* (BL.) C. CHR. Ind. Fil. (1905) 294, p.p.; Gard. Bull. S. S. 7 (1934) 250; BACKER & POSTH. Varenfl. Java (1939) 63. — *Thelypteris stegnogramma* (BL.) REED, Phytologia 17 (1968) 466. — Type: BLUME, Java.

*Phegopteris stegnogramma* var. *meniscioides* v.A.v.R. Bull. Jard. Bot. Btzig II, 16 (1914) 27; Handb. Suppl. (1917) 319. — Type: MATTHEW 584a, G. Singgalang, Sumatra (BO). — Fig. 18a-b.

*Stipe* to 40 cm long, dark, bearing long pale hairs mixed with short ones; basal scales c.  $6 \times 1$  mm; hairs on rachis to 2 mm long. *Lamina* commonly 55 cm long; pinnae 8–10 pairs, adnate to rachis except basal 2–3 pairs; lowest pinnae slightly reduced, narrowed to base on basiscopic side and slightly auricled on acroscopic, veins in auricle forked and anastomosing; texture thin, dark when dried. *Largest pinnae* commonly  $10 \times 3$  cm (to  $13 \times 3.5$  cm); aerophores swollen; base truncate to subcordate; apex short-acuminate; edges crenate; costules 5 mm apart, at a wide angle to costa; veins 8 pairs, 3 basal pairs anastomosing with zig-zag excurrent veins, next 2–3 pairs to sides of a long sinus-membrane; *lower surface* of costa bearing copious long spreading hairs mixed with shorter ones, costules and veins with shorter spreading hairs; rather sparse short erect hairs on *upper surface* of costae, shorter spreading hairs on costules and veins, sparse erect hairs between veins. *Sori* spread all along lower veins and also on the excurrent intermediate veins arising from them, usually on basal part only of distal veins.

Distr. *Malesia*: West and Central Java; Sumatra (G. Kemiri, G. Singgalang, G. Kerinci); Sabah (Mt Kinabalu). Wrongly recorded from Khasya and Ceylon by HOOKER and BEDDOME.

2. *Stegnogramma pozoi* (LAGASCA) K. IWATS. Acta Phytotax. Geobot. 19 (1963) 124, var. *petiolata* (CHING) HOLTUM, comb. nov. — *Leptogramma petiolata* CHING, Acta Phytotax. Sinica 8 (1963) 319. — Type: G. WALL ("WALLICH"), Ceylon (PE).

*Gymnogramme aspidioides* BL. En. Pl. Jav. (1828) 112, non KAULF. 1824 nec DESV. 1827. — *Gymnogramme totta sensu* BL. Fl. Jav. Fil. (1829) 90, t. 38. — *Grammitis blumeana* PRESL, Tent. Pterid. (1836) 209, nom. nov. — *Phegopteris totta sensu* METT. Farngett. IV (1858) 18, quoad pl. javan. tantum; v.A.v.R. Handb. (1908) 497, p.p.; Handb. Suppl. (1917) 515, excl. var. *subcalcarata*. — *Leptogramma totta sensu* BEDD. Handb. (1883) 377, quoad pl. zeyl. tantum. — *Dryopteris africana* (DESV.) C. CHR. Ind. Fil. (1905) 251, p.p.; BACKER & POSTH. Varenfl. Java (1939) 36. — Type: BLUME, Waterfall Tjikundal, G. Gede, Java (L).

*Stipe* 15–30 cm long; basal scales c.  $5 \times 1$  mm.

*Lamina* 25–40 cm long; pinnae 12–15 pairs of which 4–5 pairs are free, the rest  $\pm$  adnate to the rachis; basal 1–2 pairs in smaller fronds somewhat reduced, at least the lowest with stalks 1 mm long and reduced basal basiscopic lobe. *Largest pinnae* seen  $7 \times 1.6$  cm; base subequally truncate; apex entire, triangular,  $8 \times 3.5$  mm; edges lobed almost half-way to costa, lobes oblique, hardly falcate, entire; costules 4.5–5 mm apart; veins 6 pairs (or 7 veins on basiscopic side of costule), basal veins from adjacent costules usually both touching sides of sinus-membrane which may be decurrent as a ridge between them; hairs on *lower surface* of costae abundant, spreading, of varied length, longest 0.6–0.7 mm, costules and veins with shorter hairs, copious erect short hairs between veins; hairs on *upper surface* of costae mostly not over 0.5 mm long with some to 1 mm, sparse shorter hairs on costules and veins, a few thick hairs 0.5 mm long between veins. *Sori* on basal veins from costule along more than half length of vein, on distal veins shorter, medial.

Distr. Ceylon; in *Malesia*: Java.

Ecol. In Java on higher mountains, on steep earth banks in forest (BACKER & POSTHUMUS); in Ceylon at 1800 m.

Notes. The plants of Java and Ceylon here included are closely related to *S. pozoi*, the type of which was collected in northern Spain. Similar plants found in Madeira are tetraploid (MANTON). The latter differ from var. *petiolata* (diploid) in having all pinnae except the lowest adnate to the rachis, hairs on lower surfaces, confined to costae and costules, uniformly 1 mm long, and basal sori not extending to the bases of veins. Plants named *S. pozoi* occur throughout Africa; they are variable and no chromosome counts have been made. BLUME's type has pinnae to  $4.0 \times 1.3$  cm, and all pinnae above the basal ones are adnate; BACKER & POSTHUMUS report plants with fronds to  $50 \times 25$  cm but I have not seen any so large.

Prof. CHING (in lit.) informs me that the type of *Leptogramma petiolata* bears the collector's name WALL, which he interpreted as WALLICH, but it was surely G. WALL, who collected ferns in Ceylon, not WALLICH.

3. *Stegnogramma gymnocarpa* (COPEL.) K. IWATS. Acta Phytotax. Geobot. 19 (1963) 122. — *Dryopteris gymnocarpa* COPEL. in Elmer, Leaf. Philip. Bot. 3 (1910) 807. — *Phegopteris gymnocarpa* (COPEL.) v.A.v.R. Handb. Suppl. (1917) 313. — *Lastrea gymnocarpa* COPEL. Gen. Fil. (1947) 139; Fern Fl. Philip. (1960) 325, quoad typ. tantum. — *Leptogramma gymnocarpa* (COPEL.) CHING, Acta Phytotax. Sinica 8 (1963) 318. — *Thelypteris gymnocarpa* (COPEL.) MORTON, Amer. Fern J. 56 (1966) 179. — Type: ELMER 11508, Mt Apo, Falls of Cati Creek, 1750 m, Mindanao (MICH; BO, K, L etc.).

*Stipe* 2–3 cm long; hairs 1 mm long rather

sparse, many much shorter; scales little over 1 mm long. *Lamina* 9–15 cm long (COPEL.), distal half or more pinnatifid, free or adnate pinnae 3–4 pairs, lowest with stalks 1 mm long; basal pinnae  $1.0 \times 0.7$  cm, distinctly lobed; other pinnae, and lobes of terminal lamina, entire. *Veins* in lobes of basal pinnae 2–3 pairs, in lobes of terminal lamina simple or forked; *lower surface* of rachis bearing many hairs 1 mm long and few short ones, on costae and costules more sparse similar hairs, no others; on *upper surface* of rachis many short hairs and fewer 1 mm long, hairs on costae, costules and between veins sparse, 0.5 mm long. *Sori* on basal acroscopic veins on pinnae, sometimes on both branches of a forked vein on apical lamina; a majority of sporangia lacking setae.

Distr. *Malesia*: Philippines (Mindanao), only known from type.

Note. COPELAND included the Luzon plants here named *S. dissitifolia*.

**4. *Stegnogramma subcalcarata* (v.A.v.R.) HOLTUM, comb. nov.**—*Phegopteris totta* var. *subcalcarata* v.A.v.R. Handb. Suppl. (1917) 515. — Type: BECCARI 430, G. Singgalang, Sumatra, 1700 m (BO; FI, K, MEL). — Fig. 18c–e.

*Stipe* 10–12 cm long; hairs 1 mm long sparse, with shorter ones; scales small, narrow. *Lamina* to 18 cm long; free pinnae 4–5 pairs, above these 4–5 pairs gradually more broadly adnate to rachis; basal pinnae on some fronds reduced, in all cases narrowed towards base on both sides (more so on basiscopic), basal acroscopic lobe 2–3.5 mm long, almost free, stalks 1.5–2 mm long. *Largest pinnae* 3.5–5 cm long, 6.5–8 mm wide; base broadly cuneate; apex entire, triangular, 7–12 mm long, 2.5 mm wide at base; edges lobed half-way to costa, lobes subtriangular; costules 3 mm apart, at less than 60° to costa; veins 4–5 pairs, acroscopic basal vein passing to side of short sinus-membrane, basal basiscopic vein to edge above base of sinus; hairs on *lower surface* of costa sparse, 0.7 mm long with a few shorter ones, very few on costules and veins, none between veins; on *upper surface* hairs few apart from costa. *Sori* on basal acroscopic vein almost from its base, medial on other veins.

Distr. *Malesia*: Sumatra. Apart from type, known from one poor specimen from 2000 m on G. Kerinci (BÜNNEMEIJER 10480).

**5. *Stegnogramma dissitifolia* HOLTUM, sp. nov.**—*Lastrea gymnocarpa* sensu COPEL. Fern Fl. Philip. (1960) 325, p.p.

*Stipes* usque 18 cm longus; lamina usque 30 cm longa; pinnae liberae usque 12-jugatae, inferiores 6-jugatae stipitatae, maximae 3.5 cm longae, basi dilatata usque 1.2 cm lata, supra basin 0.9 cm latae, dimidio costam lobatae; pinnae infimae valde dissitae. — Type: M. G. PRICE 1668, Baguio City, Luzon (K).

*Stipes* 10–18 cm long, bearing sparse hairs 1–1.5 mm long and shorter ones; basal scales to  $5 \times 1$  mm. *Lamina* to 30 cm long; pinnae c. 12 pairs below deeply lobed apical lamina, c. 6 pairs of lower pinnae distinctly stalked, stalks to 1.5 mm; basal pinnae 2–3 cm from next pair (in another collection 5 cm), wider on basiscopic side of costa than on acroscopic and lobed more than half-way to costa, much narrowed to base on basiscopic side. *Largest pinnae* 3.5 cm long, commonly to 0.9 cm wide above dilated base which is 1.0–1.2 cm wide; base subtruncate to broadly cuneate; apex abruptly short-pointed; edges lobed about half-way to costa; costules 3–3.5(–4) mm apart; veins 3–4 pairs; on *lower surface* of rachis sparse hairs 1 mm long and many much shorter, on costae sparse hairs 0.5 mm long and a few short ones, sparse slender erect hairs between veins; hairs on *upper surface* of rachis more than 1 mm long with many short ones, costal hairs 0.3–0.5 mm, on costules fewer, scattered thick hairs 0.3–0.5 mm long between veins. *Sori* on basal half of basal veins, in middle of distal veins; sporangia all with several setae.

Distr. *Malesia*: Philippines; mountains of middle-north of Luzon at 1400–2700 m (7 collections).

Notes. Young plants of these Luzon collections differ from the small plants of comparable size from Mindanao which constitute the type of *S. gymnocarpa*; the former have more pairs of free pinnae, which are all lobed, and sporangia all have more than one seta.

*Leptogramma amabilis* TAGAWA, based on small plants from Okinawa (Ryukyu Is.) cannot be effectively compared until better known. Plants described as *S. pozoi* on Orchid Island (near the south of Taiwan) have pinnae 5 cm long.

**6. *Stegnogramma celebica* (CHING) HOLTUM, comb. nov.**—*Leptogramma celebica* CHING, Sinensia 7 (1936) 99, t. 5. — *S. gymnocarpa* (COPEL.) K. IWATS. ssp. *celebica* K. IWATS. Acta Phytotax. Geobot. 19 (1963) 123. — *Thelypteris bunnemeijeri* REED, Phytologia 17 (1968) 265. — Type: BÜNNEMEIJER 12073, G. Bonthain, Celebes (NY; BO, L).

*Stipe* to 7 cm long; hairs hardly 0.5 mm long. *Lamina* to 16 cm long; free pinnae 5 pairs, 5 pairs adnate to rachis; lowest pinnae slightly reduced, smallest seen 1.3 cm long, with stalks 1 mm long, narrowed to base on basiscopic side. *Largest pinnae* 3 cm long, 7–8 mm wide; base broadly and rather unequally cuneate; edges lobed, almost to apex, less than half-way to costa, lobes small, subtriangular; costules 2.5 mm apart, at little more than 45°; veins 3 pairs, basal acroscopic veins passing to side of sinus-membrane, basiscopic vein to edge above base of sinus (in sterile fronds, veins sometimes uniting just below sinus); hairs on *lower surface* of costae rather sparse, on fertile

pinnae hardly 0.5 mm long, on sterile pinnae longer, few hairs on costules, none between veins on fertile pinnae (a few on sterile ones); a few hairs at least 0.5 mm long between veins on *upper surface*. Sori along basal half of basal veins,

sometimes also on second veins.

Distr. *Malesia*: S.W. Celebes. Known from two collections from about 2000 m on G. Bonthain; the second is EVERETT s.n. Oct. 1895 (K, SING).

## 21. AMPHINEURON

HOLTTUM, *Blumea* 19 (1971) 45; *Blumea* 23 (1977) 205. — Fig. 19.

Caudex erect, or short- or long-creeping; scales narrow, setiferous; stipe minutely hairy, scaly at the base only except in *A. distinctum*; lamina often very large, pinnate, pinnae in most species deeply lobed; basal pinnae much narrowed at their bases; in a few species 1–2 (rarely 3) pairs of irregularly-placed and -shaped small pinnae sometimes present below the normal ones; aerophores at the bases of pinnae usually narrowly elliptic and (when dry) discoloured, not swollen; veins pinnate in the pinna-lobes, simple, basal veins either free and passing to the margin separately, or connivent at the sinus-membrane, or anastomosing to form an excurrent vein, these conditions sometimes not constant in a single frond; sinus-membrane usually ending in a prominent tooth; short acicular hairs always present on some part of the lower surface, also glandular hairs of varying size and shape, spherical to pyriform or club-shaped, the larger ones sometimes collapsing in drying to form resinous spots which may be faint and hardly detectable; sori in most species medial or supramedial; indusia usually present, bearing glands and/or hairs, apparently lacking in *A. distinctum*; glandular cells often present on the stalks of sporangia, directly attached to the stalk or at the end of a short hair, capitate hairs seen on the body of sporangia only in *A. subattenuatum*; spores usually dark, irregularly rugose or with irregular thick  $\pm$  branched ridges.

Type species: *Amphineuron opulentum* (KAULF.) HOLTTUM.

Distr. S.E. Asia; *Malesia*; Queensland; in the Pacific to Tahiti; East Africa; in all c. 12 species.

Cytol. Base chromosome number 36; *A. opulentum* (Singapore) and *A. terminans* (Ceylon) both tetraploid; no experimental work reported.

Taxon. This genus resembles *Christella* in its spores and in its mainly elongate glandular hairs; the latter are more varied than in *Christella*. The name *Amphineuron* is intended to indicate the fact that in several species the anastomosis of veins is inconstant.

The two most widely-distributed species, *A. opulentum* and *A. terminans*, are both variable, and both have a complex taxonomic and nomenclatural history. Hybrids between them probably exist, at least in Thailand. As indicated in the key, the species may be divided into two groups. Rather large glands, of varied form, occur on most species of the second group and are undoubtedly distinctive, but they are often not well preserved on herbarium specimens and are sometimes not detectable, so that such specimens are difficult to name with certainty, and I have found it impossible to be sure how many species can be recognized. The present arrangement is tentative. Specimens dried without heat retain their glands perfectly, as I have discovered when dealing with plants in cultivation at Kew. It may be that alcohol, sometimes used to preserve specimens temporarily, also has an effect on glands in this genus.

## KEY TO THE SPECIES

1. Indusia rather large, persistent; lamina thin, veins slender, slightly prominent on both sides.
2. Caudex long-creeping; pinnae lobed half-way to costa or less deeply; apex of frond  $\pm$  pinna-like  
I. *A. terminans*

2. Caudex short-creeping or erect; pinnae lobed more than half-way to costa; apex of frond not pinna-like.
3. Pinnae lobed to 1 mm from costa or more deeply; basal veins free or uniting to form very short excurrent veins.
  4. Basal veins not meeting; sori in slight depressions . . . . . 2. *A. immersum*
  4. Basal veins meeting just below the sinus, sometimes forming a short excurrent vein; sori not immersed . . . . . 3. *A. subattenuatum*
3. Pinnae lobed less deeply; basal veins anastomosing to form an excurrent vein on most parts of a frond . . . . . 4. *A. opulentum*
1. Indusia small, almost hidden by sporangia at maturity of sorus, or apparently lacking; lamina firm, veins not prominent on either surface.
  5. Hairs more than 0.5 mm long present on both sides of costa; stipe and abaxial surface of rachis bearing scales throughout . . . . . 5. *A. distinctum*
  5. All hairs on costa very short; scales confined to base of stipe.
    6. Lower surface between veins (sometimes in part) bearing very short erect acicular hairs; short capitate hairs also in this position on the upper surface . . . . . 6. *A. attenuatum*
    6. Both surfaces lacking hairs between veins.
      7. Pinnae lobed to c. 2 mm from costa, basal veins often anastomosing.
        8. Many glandular hairs on lower surface between veins, some spherical, some  $\pm$  elongate; similar hairs also on indusia . . . . . 7. *A. ceramicum*
        8. Glandular hairs less abundant, always spherical, tending to collapse and form resinous patches or to disappear on drying . . . . . 8. *A. pseudostenobasis*
      7. Pinnae lobed more deeply; basal veins not anastomosing.
        9. Pinnae thin, to 3 cm wide; glands on lower surface of pinnae and on indusia elongate . . . . . 9. *A. paraphysophorum*
        9. Pinnae firm, to 1.5 cm wide; glands on lower surface glabular to pyriform, on indusia spherical, resinous . . . . . 10. *A. kiauense*

1. *Amphineuron terminans* (HOOK.) HOLTUM, Amer. Fern J. 63 (1973) 82; Blumea 23 (1977) 207. — *Nephrodium terminans* HOOK. Spec. Fil. 4 (1862) 73, excl. syn. *N. conioneuron* FÉE & *Las-trea malaccensis* PRESL. — *Thelypteris terminans* (HOOK.) TAGAWA & K. IWATS. Acta Phytotax. Geobot. 26 (1975) 169. — Type: WALLICH 386, Burma, Kamoun (= Kumon) (K).

*Nephrodium oreopteris* FÉE, Gen. Fil. (1852) 306, non (EHRH.) DESV. 1827. — Type: CUMING 48, Luzon (holo?); isotypes G, K, LE, W).

*Thelypteris wagneri* FOSB. & SACHET, Smiths. Contr. Bot. 8 (1972) 6, excl. syn. *Polypodium pteroides* RETZ. — Type: RACIBORSKI, Java (US).

*Nephrodium pteroides* sensu BEDD. Handb. (1883) 269; RACIB. Fl. Btzig 1 (1898) 183. — *Dryopteris pteroides* sensu v.A.v.R. Handb. (1908) 209.

*Dryopteris interrupta* sensu BACKER & POSTH. Varenfl. Java (1939) 56. — *Cyclosorus interruptus* sensu HOLTUM, Rev. Fl. Malaya 2 (1955) 262, f. 149; COPEL. Fern Fl. Philip. (1960) 361. — Fig. 19a.

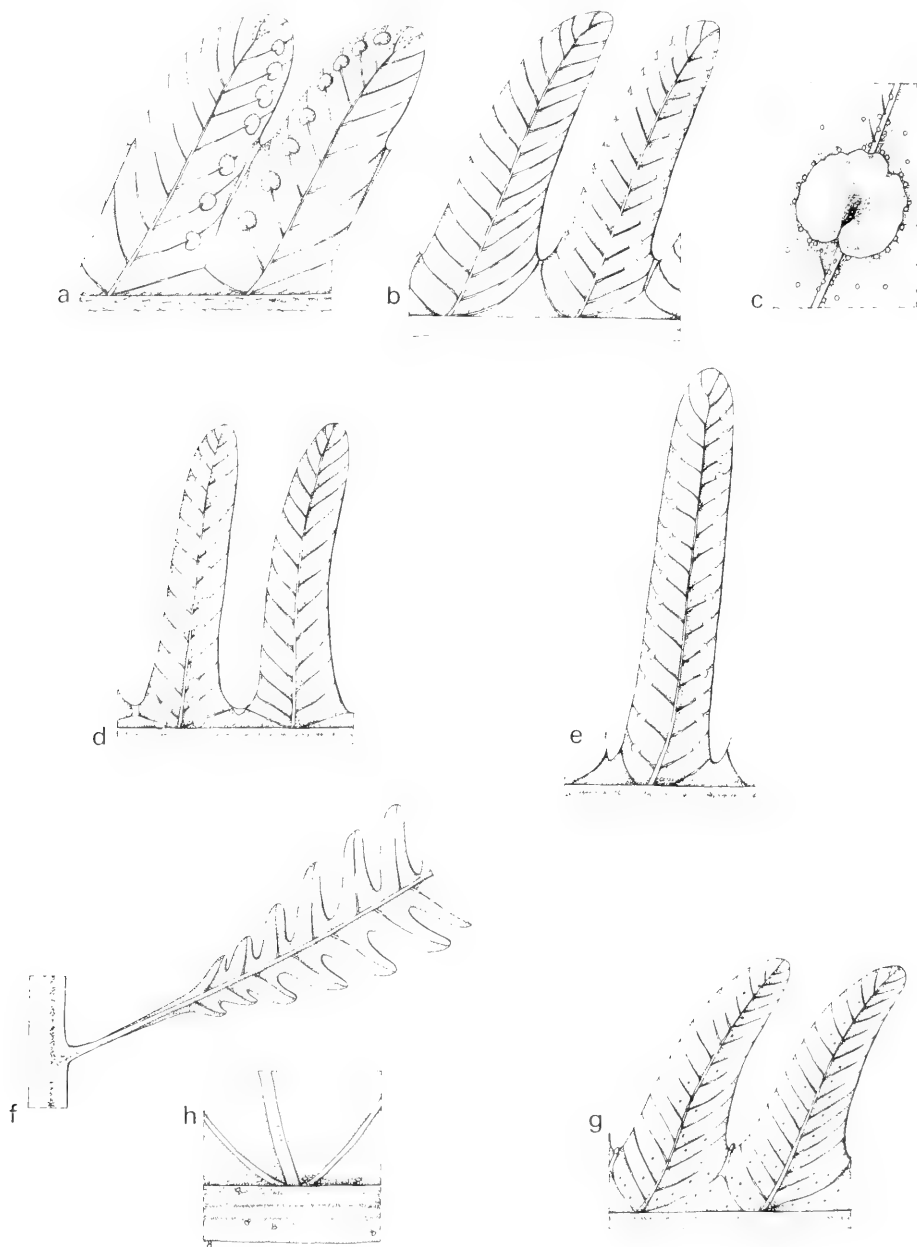
Caudex long-creeping, c. 5 mm diameter (dry); stipe commonly to 50 cm long,  $\pm$  flushed dull reddish, glabrescent abaxially, basal scales c. 8 mm long. Lamina to 50 cm long; pinnae to 25 pairs, basal pair somewhat reduced, rarely very small, always distinctly narrowed at their bases; apex of frond usually pinna-like but variable. Largest pinnae commonly 17–20  $\times$  1.7–2.0 cm, if longer not more than 2 cm wide; base of middle

pinnae broadly cuneate to truncate; apex acuminate; edges lobed 1/3 towards costa or less deeply, lobes as wide as long (or wider) with broad asymmetric apex and forward-pointing tip; costules 4–5 mm apart, usually at less than 60° to costa; veins 6–9 pairs, basal pairs spreading at a broad angle to their costules and uniting to form a rather long excurrent vein to the sinus, next veins very oblique, 1 or 2 ending beside the sinus-membrane; lower surface of rachis, costae, costules and veins bearing short acicular hairs, longer hairs usually lacking, subsessile almost spherical rather pale glandular hairs abundant on distal veins, usually few and smaller on lower veins, very short acicular hairs often present between veins; upper surface of costae bearing antrorse pale acicular hairs, similar hairs scattered on costules and veins. Sori close to margins of lobes, not on lower veins; indusia large, thin, often with some short acicular hairs and a few small glandular hairs which are not marginal.

Distr. Ceylon & S. India; Burma to Hainan and Macao; throughout Malesia; Queensland (to 18° S); one specimen from Central Africa and one from Fernando Poo.

Ecol. In Malesia only abundant in areas with a distinct dry season, in rather open but not too dry places, spreading by long rhizomes.

Notes. The complex nomenclatural and taxonomic history of this species is set forth and discussed in HOLTUM 1977. It is probable that in Thailand this species has become hybridized with *A. opulentum* but I have not seen intermediates



J.C.D.

Fig. 19. *Amphineuron terminans* (HOOK.) HOLTUM. a. Venation and sori,  $\times 4$ . — *A. opulentum* (KAULF.) HOLTUM. b. Two pinna-lobes, showing differences in course of basal veins,  $\times 3$ ; c. sorus,  $\times 18$ . — *A. subattenuatum* (ROSENST.) HOLTUM. d. Venation and sori,  $\times 3$ . — *A. immersum* (BL.) HOLTUM. e. Venation and sori,  $\times 3$ . — *A. pseudostenobasis* (COPEL.) HOLTUM. f. Base of basal pinna,  $\times 1$ ; g. two pinna-lobes,  $\times 4$ ; h. upper surface of costa with capitate hairs,  $\times 16$  (a FORMAN 145, b–c SEEMANN s.n., d WOMERSLEY & HOLTUM 17692, e MOUSSET 39, f–h HOOGLAND & CRAVEN 10122).

from Malesia. FOSBERG and SACHET used the pinna-like apex of fronds as the main distinguishing character, ignoring the evidence of venation, hairs and glands which appear to me more significant. This is the only species of *Amphineuron* in which anastomosis of veins is invariable.

**2. *Amphineuron immersum* (BL.) HOLTUM** in Nayar & Kaur, Comp. to Bedd. (1974) 203; *Blumea* 23 (1977) 211. — *Aspidium immersum* BL. En. Pl. Jav. (1828) 156; RACIB. Fl. Btzig 1 (1898) 169. — *Lastrea immersa* (BL.) MOORE, Ind. Fil. (1857) lxxxix; BEDD. Ferns Br. India (1867) t. 252; Handb. (1883) 234; COPEL. Fern Fl. Philip. (1960) 327. — *Dryopteris immersa* (BL.) O. KTZE, Rev. Gen. Pl. 2 (1891) 813; v.A.v.R. Handb. (1908) 188; BACKER & POSTH. Varenfl. Java (1939) 39. — *Thelypteris immersa* (BL.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 6 (1936) 306; HOLTUM, Rev. Fl. Malaya 2 (1955) 243. — *Parathelypteris immersa* (BL.) CHING, Acta Phytotax. Sinica 9 (1963) 303. — Type: BLUME, Java (L, n. 908, 335–404).

*Lastrea caudiculata* PRESL, Epim. Bot. (1851) 36; HOLTUM, Novit. Bot. Univ. Carol. Prag. 1968 (1969) 35. — Type: CUMING s.n. Philippines (PRC).

*Lastrea verrucosa* PRESL, Epim. Bot. (1851) 36; COPEL. Fern Fl. Philip. (1960) 327. — *Thelypteris verrucosa* (PRESL) CHING, Bull. Fan Mem. Inst. Biol. Bot. 6 (1936) 308. — Type: CUMING 72, Luzon (PRC).

?*Dryopteris diversifolia* v.A.v.R. Bull. Dép. Agr. Ind. Néerl. 18 (1908) 7; Handb. (1908) 189. — Type: RAAP 27, Sumatra, Batu Isl. (BO).

*Dryopteris besukiensis* v.A.v.R. Bull. Jard. Bot. Btzig II, 1 (1911) 7; Handb. Suppl. (1917) 156. — Lectotype (HOLTUM 1977): KOORDERS 15436, Java, Besoeeki (BO; L).

*Thelypteris subimmersa* CHING, Bull. Fan Mem. Inst. Biol. Bot. 6 (1936) 306. — *Parathelypteris subimmersa* CHING, Acta Phytotax. Sinica 8 (1963) 303. — Type: S. K. LAU 1395, Hainan (PE, not seen). — Fig. 19e.

*Caudex* short, erect; *stipe* to 70 cm or more long, green when living; basal scales thin, to 15 mm long. *Lamina* to at least 120 cm long (often fertile at a much smaller size); pinnae close, texture thin, drying pale-olivaceous; 1–2 pairs of irregularly spaced small pinnae sometimes present at base of frond. *Largest pinnae* of type 25 × 3 cm, largest seen 45 × 5 cm, lobed to 1 mm from costa or more deeply; lobes, except distally, almost at right angles to costa, separated by wide sinuses; costules 3.5–6 mm apart; veins 14–20 pairs, basal acroscopic vein ending beside the short sinus-membrane, basicopic one passing to margin above base of sinus; *lower surface* of costae and costules of type lacking acicular hairs except near apex of pinna, of other specimens bearing a variable number of hairs up to 1 mm long, costules

and veins usually bearing small pale yellow glands (abundant on the type), between veins sometimes short erect acicular and capitate hairs; *upper surface* with antorse hairs on costae and scattered hairs on costules and veins. *Sori* supramedial, in depressions in the lamina (forming convexities on the upper surface); indusia thin with a variable fringe of short yellow capitate hairs.

Distr. Assam; Hainan; southern Thailand; throughout Malesia; Queensland (to 16° S); New Hebrides, New Caledonia.

Ecol. At low altitudes, in sheltered places but not in deep shade, common on limestone in Malaya, found also on stream banks.

Notes. All the living plants observed by me have an erect caudex, but BACKER & POSTHUMUS state “wortelstok kruipend”. ERYL SMITH 2432, from Timor, is a small plant with definitely creeping caudex; it might be a hybrid with *A. opulentum*. The types of *Dryopteris diversifolia* v.A.v.R. and *D. besukiensis* v.A.v.R. are small plants, perhaps stunted owing to exposure. There is much variation in the development of acicular hairs and of small yellowish glandular hairs on the lower surface of pinnae. The types of both *Lastrea caudiculata* PRESL and *L. verrucosa* PRESL have acicular hairs, that of *Thelypteris subimmersa* CHING has none, but the published description gives no other character which would distinguish it from the type of *Aspidium immersum* BL. I know of no other record of this species in China.

**3. *Amphineuron subattenuatum* (ROSENST.) HOLTUM**, *Blumea* 23 (1977) 412. — *Dryopteris subattenuata* ROSENST. in Fedde, Rep. 10 (1912) 332. — *Thelypteris subattenuata* (ROSENST.) REED, *Phytologia* 17 (1968) 317. — Type: BAMLER 37, N.E. New Guinea, Logaueng, 300 m (S-PA?; BM). — Fig. 19d.

*Caudex* short, erect; *stipe* to at least 50 cm long, pale, basal scales c. 10 × 1.5 mm. *Lamina* 150 cm or more long; pinnae well-spaced, the lowest with very narrow bases bearing auricles 5 mm long on both sides; 1–3 pairs of much-reduced pinnae, similar auricled, present below normal ones. *Largest pinnae* 35 cm long, 2.5–3.5 cm wide, lobed to 1–1.5 mm from costa, lobes separated by wide sinuses and almost at right angles to the costa, not falcate, tips broadly rounded; costules to 6 mm apart; veins to 20 pairs, basal veins spreading at a wide angle, their tips usually touching the sides of a short sinus-membrane or sometimes uniting to form a very short excurrent vein; *lower surface* bearing a variable number of very small colourless spherical glands, sometimes also very short acicular hairs; *upper surface* of costae bearing pale acicular hairs 0.6 mm long, few hairs on costules, between veins a variable number of short acicular and capitate hairs. *Sori* a little supramedial, not impressed; indusia bearing very small glandular

hairs; sporangia sometimes with a small capitate hair; spores pale, with highly prominent thick ridges.

Distr. *Malesia*: Eastern New Guinea (6 collections).

Ecol. In somewhat exposed places near streams in forest.

**4. *Amphineuron opulentum* (KAULF.) HOLTUM**, *Blumea* 19 (1971) 45; *Blumea* 23 (1977) 212. — *Aspidium opulentum* KAULF. Enum. Fil. Chamisso (1824) 238. — *Thelypteris opulenta* (KAULF.) FOSBERG, *Smiths. Contr. Bot.* 8 (1972) 3, excl. syn. *Aspidium terminans* WALL. — Type: CHAMISSO, Guam (LE).

*Nephrodium impressum* DESV. Mém. Soc. Linn. Paris 6 (1827) 259. — *Dryopteris impressa* (DESV.) POSTH. Verh. K. Akad. Wet. Amst. 36, 5 (1937) 14; BACKER & POSTH. *Varenfl. Java* (1939) 57. — *Thelypteris impressa* (DESV.) REED, *Phytologia* 17 (1968) 284. — Type: collector not cited, Timor (P).

*Aspidium extensum* BL. En. Pl. Jav. (1828) 156. — *Nephrodium extensum* (BL.) MOORE, Ind. Fil. (1858) 91; BEDD. *Handb.* (1883) 269. — *Dryopteris extensa* (BL.) O. KTZE. *Rev. Gen. Pl.* 2 (1891) 812; v.A.v.R. *Handb.* (1908) 210. — *Cyclosorus extensus* (BL.) CHING, *Bull. Fan Mem. Inst. Biol. Bot.* 8 (1938) 182; HOLTUM, *Rev. Fl. Malaya* 2 (1955) 264, f. 150; COPEL. *Fern Fl. Philip.* (1960) 368. — *Thelypteris extensa* (BL.) MORTON, *Amer. Fern J.* 49 (1959) 113. — Type: no collector cited, Pulu Pinang (L).

*Lastrea malaccensis* PRESL, *Epim. Bot.* (1851) 35. — Type: CUMING 391, Malacca (PRC; K).

*Nephrodium conioneuron* FÉE, *Gen. Fil.* (1852) 308. — *Aspidium conioneuron* (FÉE) METT. *Farn-gatt. IV* (1858) 102. — Type: GARDNER, Ceylon (Isotype W).

*Aspidium nephroidioides* HOOK. *Spec. Fil.* 4 (1862) 162, t. 235, non KLOTZSCH 1847. — *Aspidium hookeri* BAK. *Syn. Fil.* (1867) 257, nom. nov. non KLOTZSCH 1847 — *Dryopteris orbicularis* C. CHR. Ind. Fil. (1905) 281, nom. nov. — *Thelypteris orbicularis* (C. CHR.) REED, *Phytologia* 17 (1968) 299. — Type: SEEMANN, Indian Archipelago (K). — Fig. 19b-c.

*Caudex* short-creeping; *stipe* to 70 cm long, rufescent, basal scales 10 mm long, hardly 1 mm wide. *Lamina* to 80 cm long; pinnae to 25 pairs or more; a pair of much-reduced basal pinnae sometimes present; apex of frond narrowly acuminate, deeply lobed in its basal part and grading into the upper pinnae. *Largest pinnae* commonly to 25 × 2.5 cm, largest seen 40 × 3.5 cm, lobed 3/5–3/4 towards costa; lobes slightly oblique, slightly falcate; costules commonly 4 mm apart, on large sterile fronds to 6 mm; veins 8–10(–15) pairs, basal pair both touching sinus-membrane or meeting below it at a varying angle to produce an excurrent vein; *lower surface* of rachis, costae and

costules bearing very short acicular hairs with scattered longer ones (to 0.5 mm) on costules, veins, sinus-membranes and margin, small pale yellowish glands variously distributed along costules and veins, surface between veins usually bearing some short erect acicular hairs and small colourless to yellowish capitate hairs; *upper surface* of costae covered with pale acicular hairs, similar hairs scattered on costules and veins. *Sori* confined to lobes of pinnae, supramedial, in slight depressions; indusia thin, shrivelled when old, bearing marginal yellow glandular hairs and sometimes a few acicular hairs which are not marginal; an elongate gland sometimes present on stalks of sporangia.

Distr. East Africa; Seychelles; S. India and Ceylon; Burma, Thailand; *Malesia*; N. Queensland; islands of the Pacific to Tahiti; naturalized at various places in tropical America.

Ecol. Few records; apparently adapted to semi-exposed situations among rocks, especially in areas with a dry season; in S.E. New Guinea (dry season area) found in secondary swamp-forest.

Notes. A fuller synonymy, and commentary on it, is given in HOLTUM 1977. METTENIUS published the first good description (as *Aspidium conioneuron*) with a note on the diversity of venation. The species seems not to be common in most parts of *Malesia* (doubtfully native in Java, few specimens from Borneo and the Philippines). Plants have long been cultivated in Singapore (origin unrecorded) and occur spontaneously on the edges of drains and elsewhere near the Botanic Garden; these plants are tetraploid. The center of distribution of the species is uncertain; possibly southern India.

**5. *Amphineuron distinctum* (COPEL.) HOLTUM**, *Blumea* 23 (1977) 215. — *Dryopteris distincta* COPEL. *Univ. Cal. Publ. Bot.* 18 (1942) 220. — *Cyclosorus distinctus* (COPEL.) COPEL. *Gen. Fil.* (1947) 142; Philip. J. Sci. 78 (1951) 444, pl. 26. — *Thelypteris distincta* (COPEL.) REED, *Phytologia* 17 (1968) 273. — Type: BAMLER W.11, N.E. New Guinea, Wareo, 150 m (UC).

*Dryopteris longissima* var. *novoguineensis* ROSENST. *Hedwigia* 56 (1915) 351. — Type: BAMLER 132, same locality (B).

*Caudex* unknown; *stipe* incomplete, dark at base, distally reddish, minutely hairy, bearing thin narrow scales throughout, basal ones 12 mm long; abaxial surface of rachis also bearing similar scales or their small wart-like bases. Size of *lamina* not known; basal pinnae narrowed in their basal 4 cm, base 4 mm wide. *Largest pinnae* 25 × 3 cm, rather short-acuminate, lobed to 1.5–2 mm from costa, lobes slightly oblique and slightly falcate; costules 4–4.5 mm apart; veins to 18 pairs, basal pair anastomosing to produce an excurrent vein to the sinus or passing to sides of sinus-



membrane; lower surface of rachis sparsely short-hairy, of costae bearing copious erect hairs more than 0.5 mm long, fewer such hairs on costules and veins, between veins copious slender erect acicular hairs and small  $\pm$  yellowish capitate hairs; upper surface of costae bearing thick acicular hairs and small capitate ones, shorter hairs of both kinds present between veins. *Sori* inframedial, exindusiate; hairs on stalks of sporangia consisting of 3 cells, distal ones club-shaped, orange; spores dark with irregular thick ridges.

Distr. *Malesia*: Papua New Guinea; only known from the type.

**6. *Amphineuron attenuatum*** (O. Ktze) Holtum, *Blumea* 23 (1977) 215. — *Aspidium attenuatum* Kunze ex Mett. *Farngett.* IV (1858) 96, non Sw. 1801. — *Nephrodium attenuatum* BAK. *Syn. Fil.* (1867) 263, non T. Moore 1858. — *Dryopteris attenuata* O. Ktze, *Rev. Gen. Pl.* 2 (1891) 812, *nom. nov.*; v.A.v.R. *Handb.* (1908) 184. — *Dryopteris stenobasis* C. Chr. *Ind. Fil.* (1905) 294, *nom. nov. superfl.* — *Thelypteris stenobasis* (C. Chr.) Ching, *Bull. Fan Mem. Inst. Biol. Bot.* 10 (1941) 254. — *Mesoneuron attenuatum* (O. Ktze) Ching, *Acta Phytotax. Sinica* 8 (1963) 326. — *Thelypteris attenuata* (O. Ktze) Morton, *Contr. U.S. Nat. Herb.* 38 (1967) 35. — Type: Cuming 327, Samar (B; BRI, E, G, K, L, LE, SING, US).

*Dryopteris superficialis* v.A.v.R. *Bull. Jard. Bot. Btzg II*, 20 (1915) 12; *Handb. Suppl.* (1917) 155. — Type: SA-ANAM 125, Obi I. (BO; L).

*Dryopteris erubescens sensu* Christ, Philip. J. Sci. 2 (1907) Bot. 210. — *Lastrea erubescens sensu* Copel. *Fern Fl. Philip.* (1960) 329.

*Cyclosorus alatellus sensu* Copel. *Fern Fl. Philip.* (1960) 341, *excl. syn.*

*Caudex* short, erect or suberect; *stipe* to at least 60 cm long, glabrous, rufescent, basal scales thin, to c. 10  $\times$  1 mm. *Lamina* to 80 cm or more long; lower pinnae much narrowed towards their bases, the narrowed part several cm long, distinctly lobed throughout; no reduced pinnae seen. *Largest pinnae* 30  $\times$  2 cm, lobed to 1.5 mm from costa; apex gradually attenuate to a cauda 3–5 cm long; lobes slightly oblique and slightly falcate; costules 4–4.5 mm apart; veins to 18 pairs, basal pair with upcurved tips passing to sides of sinus-membrane or rarely joining just below the membrane; lower surface of costae and costules bearing scattered minute capitate hairs, between veins slender short acicular hairs variably present on different parts of the same frond, also short capitate hairs and almost spherical red resinous glands; upper surface of costa bearing very short capitate hairs, also acicular hairs distally, some capitate hairs present between veins. *Sori* somewhat inframedial, lower ones divergent; indusia small with copious marginal spherical red resinous glands; spores dark, rugose.

Distr. *Malesia*: Philippines (Luzon, Samar, Mindanao), Moluccas (Obi Island), N. Celebes?

Ecol. "Edge of forest, petrophytic and terrestrial" on limestone and limestone-derived soils (M. G. Price, on Samar), but probably not confined to limestone.

Note. The hairs on the lower surface of pinnae are inconstant. I am not sure of a clear distinction between this species and *A. ceramicum*. A specimen collected by H. H. Bartlett (n. 7693) from Asahan, Sumatra has hairs on the lower surface as in the type of *A. attenuatum*, but glands are not well preserved. Endert 4165 from E. Kalimantan is similar.

**7. *Amphineuron ceramicum*** (v.A.v.R.) Holtum, *Blumea* 23 (1977) 217. — *Phegopteris ceramica* v.A.v.R. *Bull. Dép. Agr. Ind. Néerl.* 18 (1908) 15; *Handb.* (1908) 506. — Type: Treub s.n. Ceram (BO).

*Polypodium erubescens sensu* Hook. *Spec. Fil.* 4 (1862) 236, *quoad pl. Molucc. tantum.* — *Polypodium erubescens var. amboinense* BAK. *Syn. Fil.* (1867) 306. — Type: collector not cited, Amboina, ex Herb. Webb (K; FI, P).

*Dryopteris logavensis* Rosenst. in Fedde *Rep.* 10 (1912) 232. — Lectotype (Holtum 1977): Bاملer L34 (S-PA; BM).

*Phegopteris mamberamensis* v.A.v.R. *Bull. Jard. Bot. Btzg II*, 24 (1917) 3; *Handb. Suppl.* (1917) 516. — Type: Thomson 645, W. New Guinea, Mamberamo River (BO; L).

*Dryopteris moluccana* C. Chr. *Dansk Bot. Ark.* 9 (1937) 64. — Type: Forbes 3273, Amboina (BM; B).

Differing uncertainly from *A. attenuatum* as follows: basal pinnae gradually contracted at their bases to a narrow wing along the costa; no short acicular hairs on lower surface of pinnae between veins, no capitate hairs in that position on the upper surface; glands between veins on the lower surface varying from spherical to pyriform; glands on indusia spherical, resinous.

Distr. *Malesia*: Moluccas (Amboina, Halmahera, Ceram), New Guinea.

Note. The type of *Phegopteris ceramica* v.A.v.R. does not show glands on the lower surface; it has pinnae to 22  $\times$  1.6 cm. Hooker's Amboina specimen which he wrongly included in *Polypodium erubescens* is larger, with pinnae to 30  $\times$  3 cm, the glands on the lower surface well preserved, those near sinuses distinctly elongate. A specimen of De Vriese from Ceram at Kew is similar but sterile.

**8. *Amphineuron pseudostenobasis*** (Copel.) Holtum, *comb. nov.* — *Dryopteris pseudostenobasis* Copel. *J. Arn. Arb.* 10 (1929) 176. — *Thelypteris pseudostenobasis* (Copel.) Reed, *Phytologia* 17 (1968) 306. — Type: Brass 1000, S.E. New Guinea, Vailala River (A; BRI, UC).

*Cyclosorus alatellus* sensu COPEL. Philip. J. Sci. 78 (1951) 445, p.p. — Fig. 19f–h.

Differing from *A. attenuatum* as follows: no acicular hairs on lower surface between veins, no capitate hairs in this position on upper surface; glands between veins on lower surface fewer, apparently spherical, tending to collapse and form irregular thin patches of resinous substance or to disappear on drying of specimens; indusia very small, none seen bearing glands (which are possibly present on living fronds).

Distr. Solomon Islands and Malesia: S.E. New Guinea.

Ecol. In riverine forest "in large masses" (BRASS).

Notes. The type has pinnae to 26×1.8 cm, veins 11 pairs; pinnae on BRAITHWAITE's specimens from the Solomon Islands are up to 40×4 cm (n. 4505) with veins to 25 pairs. Two of BRAITHWAITE's specimens (4505 from Kolombangara and 4014 from Guadalcanal) certainly have a creeping caudex; his n. 4188 from San Cristobal has the note "rhizome short, erect", but otherwise is little different from the others. Spreading resinous glands are only observable on n. 4505.

9. *Amphineuron paraphysophorum* (v.A.v.R.) HOLTUM, Blumea 23 (1977) 217, excl. syn. *Dryopteris kiauensis* C. CHR. — *Dryopteris paraphysophora* v.A.v.R. Bull. Jard. Bot. Btzg III, 2 (1920) 143. — Type: C. J. BROOKS 250S, Sumatra, Lebong Tandai (BO; BM).

Caudex short, erect or suberect; stipe to 80 cm long, basal part (up to 20 cm in large fronds) copiously scaly, scales thin, narrow, 7–8 mm long. Lamina to 100 cm long (but plants of smaller size may be fertile), texture rather thin; pinnae to 28 pairs; lower pinnae not reduced but 8–10 pairs gradually narrowed towards their bases, lobes on basal 2 cm of lowest pinnae 1–2 mm long, then gradually increasing to a maximum at 7 cm from base. Largest pinnae 25–35 cm long, 2.0–3.5 cm wide (widest on sterile fronds), apex acuminate but not long-caudate; edges lobed to 1 mm from costa or more deeply; costules 3–4 mm apart; lobes hardly falcate, at more than 60° to costa; veins to 20 pairs, basal acroscopic vein spreading at a wide angle and abruptly upcurved near its tip which touches the sinus-membrane or ends just

above it, basal basicopic vein more often ending above base of sinus; lower surface of rachis and costae bearing very short capitate hairs only, on costules, veins and between veins many pyriform to almost cylindrical yellow glands; upper surface of rachis bearing capitate hairs only, basal parts of costae the same, acicular hairs up to 0.3 mm long present on distal parts, very short ones also on costules. Sori medial, lower ones divergent; indusia small, lacerate, with elongate yellow glands on the margin; sporangia sometimes with similar glands on their stalks; spores with few large thick protuberances of varied shape.

Distr. Malesia: S. Sumatra and Borneo (Sarawak).

Ecol. In Sarawak, in open places in forest at 90 m alt.

Notes. Part of the above description is based on a plant from Gunong Mulu in Sarawak cultivated at Kew. This shows the abundance of glands of a distinctive shape on the lower surface of pinnae and on indusia. The glands on a dried specimen from the same locality are so shrivelled as to be hardly distinguishable.

10. *Amphineuron kiauense* (C. CHR.) HOLTUM, comb. nov. — *Dryopteris kiauensis* C. CHR. Dansk Bot. Ark. 9, 3 (1937) 64. — Type: ENDERT 4632 (wrongly cited as 4433), E. Kalimantan, Kutai, Kiau, 700 m (BO; L, SING).

Description of type: stipe to 100 cm long; lamina to 100 cm long, texture firm; pinnae (fertile) to 18×1.5 cm, lobed to 1–1.5 mm from costa; basal 2 cm of basal pinnae consisting of a narrow wing above which is a gradual transition to full width of the pinna; veins 8–10 pairs, basal pair touching sides of sinus-membrane without anastomosis; short capitate hairs present on lower surface of costae, no glands detectable between veins; sori inframedial; indusia small, lacerate.

Specimens from Sabah (KAKAWA & HOTTA 1291, distributed as *Thelypteris erubescens*) are very similar but have many spherical to pyriform glands on the lower surface, especially near the sinuses, and spherical resinous reddish glands on indusia. It seems probable that these represent the same species as the type of *A. kiauense*; there is a similar specimen (CLEMENS 29765) from Mt Kinabalu, 1200 m.

Distr. Malesia: Borneo.

## 22. CHRISTELLA

LÉVEILLÉ, Fl. de Kouy-tchéou (1915) 472, emend. HOLTUM, Taxon 20 (1971) 533, Blumea 19 (1971) 43, Kew Bull. 31 (1976) 293. — *Nephrodium* SCHOTT, Gen. Fil. (1834) t. 10 et sp. *N. molle tantum*, non RICHARD 1801. — *Thelypteris* subg. *Cyclosoriopsis* K. IWATS. Mem. Coll. Sci. Univ. Kyoto B, 31 (1964) 28, p.p. — *Cyclosorus* sensu auctt. plur. p.p. — Fig. 1i, p, 20.

Caudex erect, suberect or creeping, in some species slender and wide-creeping; scales almost always narrow with many superficial hairs. Lamina in almost all species with 1–5 (rarely to 10) pairs of lower pinnae gradually decrescent, the lowest usually not less than 2 cm long and in almost all cases auricled on the acroscopic base, aerophores at the bases of pinnae not swollen; largest pinnae shallowly to deeply lobed, bearing erect acicular hairs (in some species minute) on all parts of the lower surface, also in almost all species between veins on the upper surface (these hairs never appressed), small capitate hairs sometimes also present; thick orange-red glandular hairs (not erect) present in some species on costules and veins on lower surface, sessile spherical glands lacking; veins free in a few species, in most species at least the basal veins from adjacent costules anastomosing, in some cases several pairs; sori indusiate (except in *C. nana* and *C. buwaldae*); sporangia lacking hairs or glands distally (except in some specimens of *C. subpubescens*) but bearing unicellular elongate glandular hairs on their stalks (except in spp. 1–4); spores dark, variously tuberculate or ridged, lacking thin wings.

Type species: *Christella parasitica* (L.) LÉV.

Distr. About 50 spp.; throughout the warmer parts of the Old World; one species (*C. hispidula*) also in the neotropics; in addition c. 15–20 spp. in Africa and the neotropics the status of which still needs to be established.

Ecol. In Malesia, almost all are ferns of open places; species confined to forest occur in the region from N.E. India and Burma to S. China.

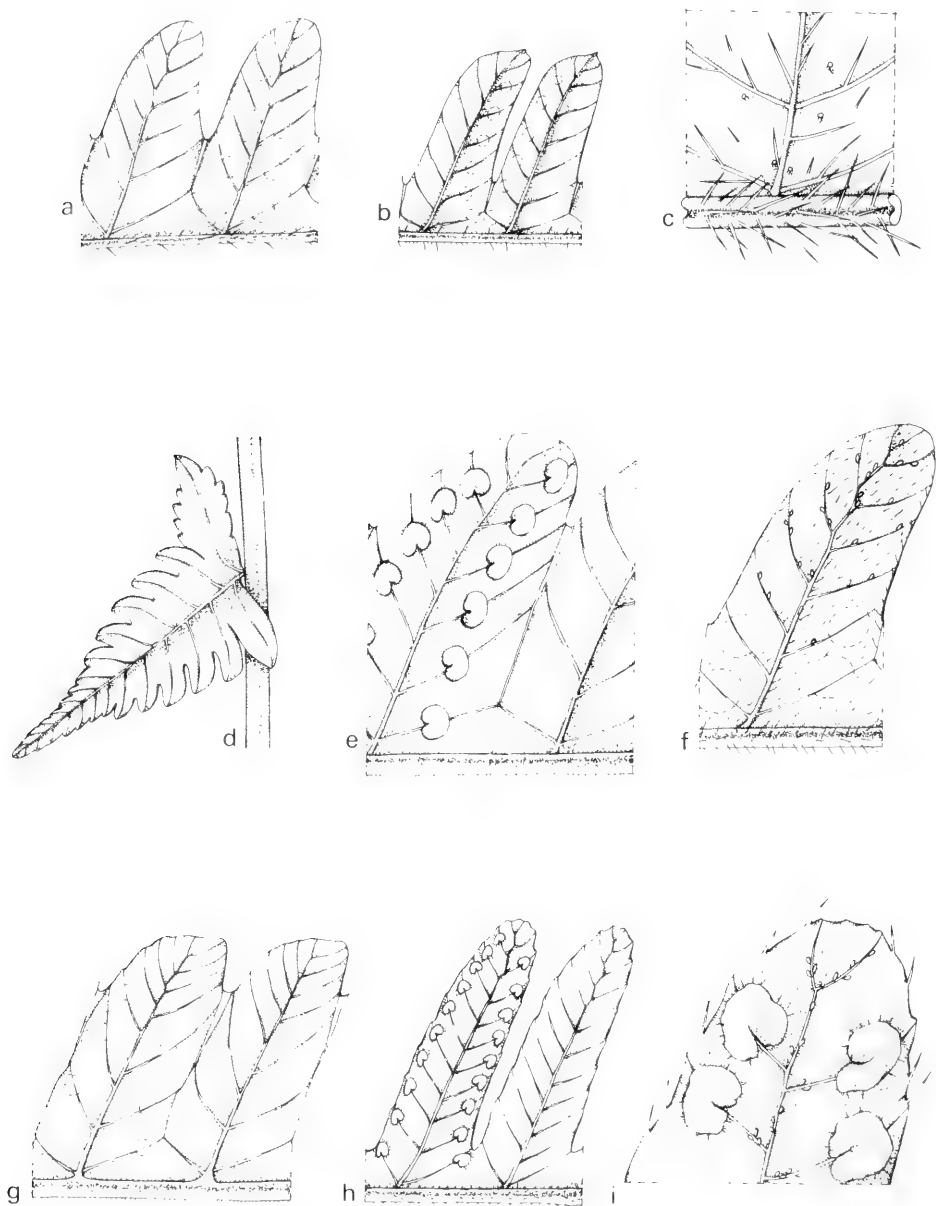
Cytol. Base chromosome number 36. *C. dentata*, *C. parasitica* and *C. subpubescens* are tetraploid, *C. hispidula* diploid. Experimental hybridization of these species was undertaken at Leeds (see HOLTUM 1976, p. 295); *C. dentata* and *C. parasitica* were shown to be allotetraploids with *C. hispidula* as one parent of each. *C. arida* has been shown to be diploid in northern India but has not been experimentally hybridized with tetraploids. It is evident that natural hybrids between some of the commoner species have also developed, but it is difficult to assign a parentage to them.

Taxon. LÉVEILLÉ characterized his genus as follows: pinnae lobed, with simple veins pinnately arranged in the lobes, sori with reniform indusia, seated on the veins in a row on each side of the costules. No type species was indicated. The characters apply to most species of *Thelypteridaceae*, and LÉVEILLÉ's list included representatives of four genera as arranged in the present treatment, also two which do not belong to the family. Three of his species were transferred to other genera by CHING; several others do not strictly conform to LÉVEILLÉ's own generic definition. Three of his species are closely allied and belong to a group recognized by me in my preliminary studies of the family, for which I was seeking an appropriate generic name; I therefore chose a species from this group as type. In 1964 IWATSUKI had cited an allied species, *C. dentata*, as type of *Thelypteris* subg. *Cyclosoriopsis*, but his definition of the subgenus would include many species which seem to me not nearly allied.

In the earlier literature the species of this genus were not clearly distinguished, so that there is much confusion in the use of names. I have not attempted to assign meanings to all names cited; e.g. *Aspidium patens*, *A. nymphale* and *A. parasiticum* in BLUME's 'Enumeratio' of 1828 are not clearly distinguished and I have not found the particular specimens to which he gave those names, which were copied from earlier works by others, who had described them very briefly.

The single most distinctive character is the presence of an elongate unicellular gland on the stalks of sporangia (shown in SCHOTT's figure of 1834 but mentioned by no-one else); similar glands are also present on the lower surface of pinnae in some species. This character is associated with others less precisely definable, among them the rather thick protuberances or ridges of the perispore, a character shared by *Amphineuron*. But the elongate gland on the sporangium-stalk is lacking in a group of four species in New Guinea, for which I propose a new section as follows:

**Leptochristella** HOLTUM, sect. nov. — *Plantae parvae, calcicolae; pinnae 2–4.5 cm longae, tenues, subtus omnino piliferae; venae liberae vel inferiores anastomosantes; sori indusiati vel exindusiati; pedicelli sporangiorum glandulis destituti, interdum pilis acicularibus praediti.*



JCD

Fig. 20. *Christella dentata* (FORSSK.) BROWNSEY & JERMY. *a*. Two pinna-lobes,  $\times 4$ . — *C. hispidula* (DECNE) HOLTUM. *b*. Two pinna-lobes,  $\times 4$ ; *c*. upper surface of costa and base of costule, showing acicular and capitate hairs,  $\times 18$ . — *C. papilio* (HOPE) HOLTUM. *d*. A reduced basal pinna,  $\times 1$ ; *e*. venation and sori, showing minute hairs on costa,  $\times 6$ . — *C. parasitica* (L.) LÉV. *f*. Pinna-lobe, showing hairs and glands,  $\times 6$ . — *C. subpubescens* (BL.) HOLTUM. *g*. Venation and sori,  $\times 4$ . — *C. harveyi* (METT.) HOLTUM. *h*. Two pinna-lobes,  $\times 4$ ; *i*. tip of a pinna-lobe showing sori, glands and hairs,  $\times 16$  (*a* PIGGOTT 1479, *b-c* YAPP 201, *d-e* MOLESWORTH ALLEN 4949, *f* HOLTUM s.n., *g* WALLICH 354, *h-i* BRYCE 5).

Type species: *Christella perpubescens* (ALSTON) HOLTUM.

The plants of this group of species, small in stature and consequently simplified in structure, are difficult to characterize and need more study. They have the frond-form of *Christella* with lower pinnae gradually and slightly reduced (shown most notably by *C. perpubescens*), abundant slender acicular hairs (fewest in *C. nana*) and spores of the *Christella* type. I see no other genus to which they could be considered allied.

In Africa also are species with free veins and lacking (so far as I have observed) glandular hairs on the stalks of sporangia. For them I proposed the sectional name *Pelazoneuron* (J. S. Afr. Bot. 40, 1974, 144) but they appear to be related to a group of tropical American species in which glandular hairs of the *Christella* type do occur on the stalks of sporangia of at least two species (A. R. Smith, Univ. Cal. Publ. Bot. 29: 15, 66, 79) and apart from their free veins I see no clear distinction between these American species and *C. hispidula*. A few species in the Western Pacific (including *C. harveyi* in the present work) also have free veins; I suggest that they are derived from Malesian species with anastomosing veins.

KEY TO THE SPECIES

1. Limestone plants; pinnae not over 4.5 cm long; no elongate glands on stalks of sporangia (*sect. Leptochristella*).
2. Indusia distinctly present.
3. Pinnae to 27 pairs, 5–7 lower ones gradually reduced . . . . . 1. *C. perpubescens*
3. Pinnae c. 6 pairs, lowest only slightly reduced . . . . . 2. *C. minima*
2. Indusia lacking or not clearly distinguishable.
4. Pinnae lobed almost to costae; veins all free . . . . . 3. *C. nana*
4. Pinnae lobed less deeply; veins near bases of pinnae anastomosing . . . . . 4. *C. buwaldae*
1. Plants not confined to limestone; pinnae commonly 10 cm or more long; elongate glands present on stalks of sporangia (*sect. Christella*).
5. Veins all free.
6. Red ellipsoid glands present on lower surface of pinnae . . . . . 5. *C. harveyi*
6. Such glands lacking . . . . . 6. *C. peekelii*
5. At least the basal veins anastomosing.
7. At least 3 pairs of lower pinnae gradually reduced.
8. Sinus-membrane prominent on lower surface, 3 pairs of veins ending beside it; reduced pinnae hardly auricled . . . . . 7. *C. arida*
8. Sinus-membrane not prominent, at most 1½ pairs of veins ending beside it; reduced pinnae clearly auricled.
9. Caudex strictly erect.
10. Reduced pinnae c. 8 pairs; hairs on lower surface of costae c. 0.1 mm long . . . . . 8. *C. papilio*
10. Reduced pinnae 3–4 pairs; some hairs on lower surface of costae 0.3 mm or more long.
11. Pinnae lobed less than half-way to costa; hairs on lower surface of costae all less than 0.5 mm long . . . . . 9. *C. adenopelta*
11. Pinnae lobed more than half-way to costa; hairs on lower surface of costae mostly more than 0.5 mm long . . . . . 10. *C. hispidula*
9. Caudex short-creeping, or at most suberect distally.
12. Pinnae lobed at least half-way to costa; only 1 pair of veins truly anastomosing; some hairs 0.3 mm long present on lower surface of costae . . . . . 11. *C. dentata*
12. Pinnae lobed 1/4–1/3 towards costa; at least 1½ pairs of veins truly anastomosing; all hairs on lower surface of costae c. 0.1 mm long . . . . . 12. *C. subpubescens*
7. At most 3 pairs of lower pinnae gradually reduced.
13. Hairs on lower surface of costae all very short.
14. Pinnae lobed c. 1/4; minute capitate hairs present in addition to acicular hairs on lower surface of pinnae . . . . . 12. *C. subpubescens*
14. Pinnae lobed c. 2/5; no capitate hairs on lower surface . . . . . 13. *C. subdentata*
13. Hairs on lower surface of costae always conspicuous, to 1 mm long.
15. Caudex long-creeping.
16. Pinnae lobed more than 1/2; apices of pinna-lobes not apiculate.
17. Basal 1–1½ pairs of veins anastomosing, 1 pair passing to sinus-membrane . . . . . 14. *C. timorensis*
17. Basal 1 pair of veins anastomosing, at most the next acroscopic vein meeting the sinus-membrane . . . . . 15. *C. parasitica*
16. Pinnae lobed less than 1/2; apices of pinna-lobes apiculate . . . . . 16. *C. acuminata*
15. Caudex short-creeping or erect.

18. Pinnae lobed much more than 1/3; some hairs more than 0.5 mm long present on lower surface.  
 19. Caudex erect; 2 or more pairs of lower pinnae reduced . . . . . 10. *C. hispidula*  
 19. Caudex not erect; basal pinnae not reduced . . . . . 15. *C. parasitica*  
 18. Pinnae lobed little more than 1/2; hairs on lower surface all less than 0.5 mm long  
 11. *C. dentata*

1. *Christella perpubescens* (ALSTON) HOLTUM, Kew Bull. 31 (1976) 304. — *Dryopteris perpubescens* ALSTON, J. Bot. 78 (1940) 227; Nova Guinea n.s. 4 (1940) 111, pl. 8, f. 9, 10. — *Thelypteris perpubescens* (ALSTON) REED, Phytologia 17 (1968) 303. — Type: CLEMENS 7902C, N.E. New Guinea, Morobe Distr., Kalasa (B; BM).

*Caudex* short-creeping; *stipe* 3–5 cm long, densely short-hairy throughout, basal scales 5 mm long, narrow, soft, covered with minute hairs. *Lamina* 22 cm long; texture thin; pinnae to 27 pairs, c. 7 pairs of lower ones gradually decrescent, basal pinnae 3–5 mm long; apex of frond also gradually attenuate. *Largest pinnae* of type 2.8 × 0.9 cm (sterile), 2.2 × 0.8 cm (fertile), sessile, short-acuminate, lobed to 0.5 mm from costa, basal pair of lobes sometimes separately adnate to the costa, the acroscopic lobe not elongate but sometimes with a sinuous margin; costules 2.5–3 mm apart; veins to 4 pairs, free, basal acroscopic one sometimes touching side of sinus-membrane, basiscopic one to margin above base of sinus; *lower surface* of rachis and costae densely covered with short hairs, scattered hairs more than 0.5 mm long also present, costules, veins and surface between veins bearing many short erect acicular hairs, also pale capitate hairs; *upper surface* throughout bearing slender erect acicular hairs, also some capitate hairs. *Sori* medial or a little supramedial; indusia firm, hairy; no hairs seen on sporangium-stalks; spores dark, closely and irregularly tuberculate.

Distr. Solomon Islands; *Malesia*: New Guinea.

Ecol. On limestone cliffs near sea-level (Waigeo Island and Solomons); in eastern New Guinea reported to occur in rock crevices (type and BRASS 23774) at 240–500 m.

Note. BRASS 23774, from Milne Bay District, lacks capitate hairs, and also BRAITHWAITE 4841 from the Solomon Islands; the latter also differs in longer stipes and less reduced basal pinnae. L. E. CHEESMAN 1227 from Waigeo Island has pinnae to 4.5 cm long, and a few capitate hairs.

2. *Christella minima* HOLTUM, Kew Bull. 31 (1976) 304. — Type: JERMY 7875, New Ireland, on limestone (BM).

*Caudex* short, apparently erect; *stipe* to 4.5 cm long, slender, short-hairy, basal scales c. 3 mm long. *Lamina* to 9 cm long, texture very thin; pinnae 6 pairs; basal pinnae a little reduced, with enlarged basal acroscopic lobes; apex of frond gradually attenuate. *Largest pinnae* 1.8 × 0.9 cm, lobed a little more than halfway to costa; apex obtuse, lobes rounded, entire; costules 3 mm

apart; veins free, to 4 pairs in the largest lobes, basal acroscopic vein ending at base of sinus, basiscopic one above base of sinus; *lower surface* covered throughout with slender short hairs, some longer ones present on rachis and costae; *upper surface* covered with short slender hairs, some longer ones also present on costules and veins. *Sori* supramedial, on basal acroscopic veins, a few on the second vein; indusia bearing many slender hairs; spores very dark with irregular blister-like protuberances.

Distr. *Malesia*: New Guinea (New Ireland), only known from the type.

Note. This may be an immature state of *C. perpubescens*.

3. *Christella nana* HOLTUM, Kew Bull. 31 (1976) 304. — Type: MCKEE 1938, W. New Guinea, Biak Island (L).

*Caudex* short-creeping; *stipe* 4–5 cm long, glabrous, basal scales 1.5 mm long, narrow. *Lamina* dimorphous, c. 7 cm long, thin; pinnae 6 pairs, wider on basiscopic than on acroscopic side of costa, basal pair a little reduced. *Sterile pinnae* to 3.0 × 1.0 cm, with stalks 1 mm long, lobed almost to the costa near base; lobes oblique, entire, with rounded tips, basal acroscopic lobe a little enlarged; apex of pinnae obtuse; costules to 3 mm apart; veins to 4 pairs, free, both basal ones passing to margin above base of sinus; *lower surface* of rachis covered with stiff erect hairs of varying length, costae and costules bearing very short somewhat antrorse hairs, rest of surface glabrous; *upper surface* glabrous apart from the costae. *Fertile pinnae* to 2.0 × 0.6 cm; sinuses between lobes wider than in sterile pinnae; veins in largest lobes 3 pairs, costules in upper pinnae once forked; *sori* confined to the pinna-lobes, on upper pinnae 1 or 2 in each lobe; no indusia; spores as in *S. minima*.

Distr. *Malesia*: New Guinea (Biak I.), only known from type.

Ecol. Beneath overhanging coral rock just above beach.

4. *Christella buwaldae* (HOLTUM) HOLTUM, *comb. nov.* — *Pronephrium buwaldae* HOLTUM, Blumea 20 (1972) 115. — Type: BUWALDA 4979, Aru Islands, P. Kobroör (L; K).

*Caudex* short-creeping; *stipe* to 8 cm long, slender, covered with short pale erect hairs, basal scales to 5 mm long, narrow, with superficial short hairs. *Lamina* of type 16 cm long consisting of an apical section 13 cm long, widening downwards and deeply lobed, the lobes veined as pinnae, with

2–3 pairs of free pinnae; texture very thin, translucent; basal pinnae somewhat reduced. *Largest pinnae*  $2.8 \times 1.0$  cm, sessile or with very short stalks; base symmetrically broadly cuneate; apex abruptly obtuse; edges lobed  $1/3$  towards costa, lobes subtriangular; costules 3 mm apart; veins 3–4 pairs, basal pair anastomosing except near apex of pinna; *lower surface* of rachis, costae and costules covered with erect hairs of varying length, longest almost 1 mm long, surface between veins bearing very slender erect hairs; *upper surface* similarly hairy. *Sori* small, on pinnae inframedial, on lobes of apical lamina supramedial; no indusia but acicular hairs present on the receptacle (or a very small hairy indusium?); sporangia lacking glands or setae; spores light brown.

Distr. *Malesia*: Moluccas (Buru & Aru Is.).

Ecol. On P. Kbroör "in forest" (the island is mainly limestone); on Buru "limestone, 1200 m" (TOXOPEUS *s.n.* 4 Sept. 1921, BO).

Note. The Buru specimen is larger than the type, with an apical lamina 8 cm long and c. 6 pairs of free pinnae, largest pinnae  $3.2 \times 1.3$  cm, lobed more deeply than those of the type; in other respects it agrees. An acicular hair was observed on the stalk of a sporangium of the Buru specimen, and the pubescence of the frond is very like that of *C. perpubescens*, not like that of any species of *Pronephrium*, from which genus the species is here transferred. But the spores of the type need a careful re-examination; sporangia of the Kew isotype are immature.

**5. *Christella harveyi* (METT.) HOLTUM**, Kew Bull. 31 (1976) 306; Allertonia 1 (1977) 219, f. 8 A-D. — *Aspidium harveyi* METT. in Kuhn, Linnaea 36 (1869) 115. — *Dryopteris harveyi* (METT.) O. KTZE, Rev. Gen. Pl. 2 (1891) 812; C. CHR. Bishop Mus. Bull. 177 (1943) 83. — *Thelypteris harveyi* (METT.) PROCTOR ex K. IWATS. Amer. Fern J. 53 (1963) 133. — Type: HARVEY, Fiji (B; K).

*Dryopteris euaensis* COPEL. Univ. Cal. Publ. Bot. 12 (1931) 391. — Type: PARKS, Tonga (UC; BM, K).

*Thelypteris novae-hiberniae* HOLTUM, Dansk Bot. Ark. 25, 2 (1967) 50. — Type: KÖIE 1848, New Ireland (C).

*Nephrodium patens sensu* HOOK. Spec. Fil. 4 (1862) 95, p.p. — *Dryopteris patens sensu* v.A.v.R. Handb. (1908) 189, p.p. — **Fig. 20h–i.**

*Caudex* long-creeping, 5–7 mm diameter when dry; *stipe* 20–30 cm long, hairy in groove, basal scales to  $8 \times 1.5$  mm. *Lamina* 50–70 cm long, texture thin; pinnae 20–25 pairs; lower pinnae variously reduced, lowest sometimes only 3 cm long; reduced pinnae more widely spaced, sometimes with basal acroscopic lobe enlarged and lobulate. *Largest pinnae* commonly  $15\text{--}20 \times 1.5\text{--}2.2$  cm, rarely to 3 cm wide; base not auricled; apex caudate-acuminate; edges lobed to  $1\text{--}1.5$  mm

from costa; lobes oblique, slightly falcate, entire, with rounded apices; costules 4–4.5 mm apart; veins 10–12 pairs, basal acroscopic one passing to side of the short sinus-membrane, basiscopic one to margin above base of sinus; *lower surface* of rachis, costae and costules bearing copious short hairs and a variable number of longer ones, some thick orange glandular hairs present on costules and veins, between veins a variable number of slender short erect acicular hairs and glandular hairs; *upper surface* of costae densely hairy, scattered long hairs present on costules and veins, between veins a variable number of short suberect hairs and sometimes glandular hairs. *Sori* near margin; indusia firm, glabrous or with a few hairs; an orange glandular hair on the stalks of some sporangia.

Distr. Solomon Islands, New Hebrides, Fiji, Samoa, Wallis Island, Tonga, in *Malesia*: New Guinea (Admiralty Islands, Bismarck Archipelago).

Ecol. In open places in forest at 0–1000 m.

**6. *Christella peekelii* (v.A.v.R.) HOLTUM**, Kew Bull. 31 (1976) 306. — *Dryopteris peekelii* v.A.v.R. Bull. Dép. Agr. Ind. Néerl. 18 (1908) 7; Handb. (1908) 188. — Type: PEEKEL 44, "New Guinea" (BO).

*Caudex* probably long-creeping; *stipe* probably to 20 cm long, copiously short-hairy, basal scales not seen. *Lamine* 30–40 cm long; pinnae 18–22 pairs; basal pinnae slightly reduced, their basal pair of lobes almost free, the acroscopic one enlarged and deeply dentate. *Largest pinnae*  $10 \times 1.6$  cm (sterile),  $9 \times 1.3$  cm (fertile), acuminate, lobed to less than 1 mm from costa, lobes entire and slightly falcate; costules of sterile pinnae 4 mm apart, of fertile pinnae 3 mm; veins 8–10 pairs, arranged as in *C. harveyi*; *lower surface* bearing very short hairs throughout, no glandular hairs present; *upper surface* bearing scattered long hairs on costules and veins and short suberect hairs between veins. *Sori* near margins of lobes; indusia short-hairy; orange glands present on stalks of sporangia.

Distr. *Malesia*: Papua New Guinea (New Britain).

Note. PEEKEL collected in the Bismarck Archipelago; the type was probably found in New Ireland. It is closely related to *C. proluxa* (WILLD.) HOLTUM (*Aspidium obliquatum* METT.) of New Caledonia, which also lacks glandular hairs on the lower surface of pinnae.

**7. *Christella arida* (D. DON) HOLTUM** in Nayar & Kaur, Comp. to Bedd. (1974) 206; Kew Bull. 31 (1976) 320; Allertonia 1 (1977) 172, 225, f. 9A. — *Aspidium aridum* D. DON, Prodr. Fl. Nepal (1825) 4. — *Nephrodium aridum* (D. DON) J. SM. in Hook. J. Bot. 4 (1841) 188; BEDD. Handb. (1883) 272. — *Dryopteris arida* (D. DON) O.

KTZE, Rev. Gen. Pl. 2 (1891) 812; v.A.v.R. Handb. (1908) 212; BACKER & POSTH. Varenfl. Java (1939) 50. — *Cyclosorus aridus* (D. DON) CHING, Bull. Fan Mem. Inst. Biol. Bot. 8 (1938) 194; HOLTUM, Rev. Fl. Malaya 2 (1955) 259, f. 146; COPEL. Fern Fl. Philip. (1960) 362. — *Thelypteris arida* (D. DON) MORTON, Amer. Fern J. 49 (1959) 113. — Type: WALLICH, Nepal (not found at BM; possibly at BR, see MORTON 1974, *infra*).

*Aspidium obscurum* BL. En. Pl. Jav. (1828) 150. — *Nephrodium obscurum* (BL.) T. MOORE, Ind. Fil. (1858) 98; RACIB. Fl. Btzg 1 (1898) 125. — Type: BLUME, Java (L).

*Polypodium acuminatum* ROXB. Calc. J. Nat. Hist. 4 (1844) 490, non HOUTT. 1786; MORTON, Contr. U.S. Nat. Herb. 38 (1974) 335. — Type: ROXBURGH, "Ind. Or." (BR; G).

*Dryopteris arida* var. *ebeneorachis* COPEL. in Elmer, Leaf. Philip. Bot. 2 (1908) 390. — Type: ELMER 1044, Negros (MICH; BO, G). — Fig. 1i.

*Caudex* long-creeping, 4–5 mm diameter; *stipe* 15–30 cm long, glabrous except in groove, basal scales 5 mm long, narrow. *Lamina* to 150 cm long; pinnae to 30 pairs or more; lower 3–5 pairs gradually or subabruptly decrescent and more widely spaced, not or little auricled, lowest commonly 5–10 mm long; apex of frond almost pinna-like; texture very firm. *Largest pinnae* to 16 × 1.8 cm (width above the somewhat dilated base), acuminate, lobed c. 1/4 towards costa, lobes with a short stiff point; costules 3–4 mm apart; veins to 10 pairs, prominent beneath, 1½ pairs, at a broad angle to costule, anastomosing, next 3 pairs very oblique and passing to the sinus-membrane which is prominent on the lower surface; *lower surface* of costae bearing rather sparse stiff erect hairs 0.2 mm long and a few very narrow scales, costules and veins with scattered short acicular hairs and thick yellow glandular hairs, short erect hairs sometimes present between veins; *upper surface* of costae covered with short antrorse hairs, costules, veins and surface between veins almost or quite glabrous. *Sori* medial, lower ones divergent; indusia glabrous or with some glandular and short acicular hairs.

*Distr.* N.W. India to southern China, Thailand and Vietnam; throughout *Malesia*: N. Queensland, New Hebrides, New Caledonia, Fiji, Samoa.

*Ecol.* In open places in low country, often among tall grasses, less commonly at higher altitudes (once in Malaya at 1800 m). Plants growing in tall grass have a greater number of reduced basal pinnae than those in more exposed places.

*Note.* Reports on the distribution of this species are often erroneous because it has been confused with *Sphaerostephanos invisus* and *S. unitus* which have a similar habit (see Holttum in Al-lerton, 1977). LOYAL found a plant in North India to be diploid; some specimens are possibly hybrids with *C. subpubescens*.

**8. *Christella papilio* (HOPE) HOLTUM** in Nayar & Kaur, Comp. to Bedd. (1974) 208; Kew Bull. 31 (1976) 321. — *Nephrodium papilio* HOPE, J. Bombay Nat. Hist. Soc. 12 (1899) 625, t. 12. — *Cyclosorus papilio* (HOPE) CHING, Bull. Fan Mem. Inst. Biol. Bot. 8 (1938) 214; MOLESWORTH ALLEN, Gard. Bull. Sing. 22 (1967) 180, 185. — *Thelypteris papilio* (HOPE) K. IWATS. Mem. Coll. Sci. Univ. Kyoto B, 31 (1965) 175. — Lectotype (HOLTUM 1976): LEVIGNE s.n. 1880, N.E. India, below Darjeeling 1200 m (K).

*Nephrodium molle* var. *major* BEDD. Handb. Suppl. (1892) 76, p.p. — Fig. 20d-e.

*Caudex* massive, erect; *stipe* 10–30 cm long, minutely hairy, basal scales thin, c. 7 × 1 mm. *Lamina* to 150 cm or more long; c. 10 pairs of lower pinnae gradually decrescent, broadly triangular, strongly auricled on acroscopic base, broadly truncate on basiscopic, margins above base shallowly lobed, apex acuminate; lowest pinnae 1–3 cm long. *Largest pinnae* to 17 × 2 cm; base subtruncate; apex acuminate with short cauda; edges lobed 1/4–1/3 towards costa (most deeply in fertile pinnae), lobes slightly falcate and rounded at their tips; costules 4–4.5 mm apart; veins 7–9 pairs, 1½ pairs anastomosing, 1–2 pairs ending beside the sinus-membrane; *lower surface* of all parts bearing very short erect hairs (less than 0.1 mm long on rachis and bases of costae, a little longer on distal parts of pinnae), some thick orange glandular hairs sometimes present on veins in pinna-lobes; *upper surface* of costae covered with hairs 0.3–0.5 mm long, scattered shorter hairs on costules, minute erect hairs on surface between veins. *Sori* medial; indusia rather large, thin, with short hairs as lamina.

*Distr.* Southern India & Ceylon; N.E. India, Thailand; *Malesia*: to northern Malaya.

*Ecol.* In Malaya, in forest on sloping ground at 600–900 m.

*Notes.* The Indian specimens lack orange glandular hairs on the lower surface, but such glands are present on all specimens from Thailand and Malaya. MANTON found a Ceylon plant to be tetraploid, LOYAL found plants in N. India to be diploid.

**9. *Christella adenopelta* HOLTUM**, Kew Bull. 31 (1976) 322. — Type: W. A. SLEDGE 1698, Samoa (K).

Near *C. papilio*, with the same erect caudex and similar pubescence, but only 3–4 pairs of lower pinnae gradually decrescent, the lowest 3.5 cm long; largest pinna 12 × 1.8 cm; hairs between veins on the lower surface a little longer than in *C. papilio* and many short capitate hairs also present with them, some scattered hairs up to 0.5 mm long present distally on costae and costules; indusia large, bearing glandular hairs like those on the lower surface of veins in addition to many very short acicular hairs.



Distr. Samoa and *Malesia*: S.E. New Guinea (Brown River, near Port Moresby).

Ecol. In secondary swamp forest, low altitude.

**10. *Christella hispidula* (DECNE) HOLTUM**, Kew Bull. 31 (1976) 312. — *Aspidium hispidulum* DECNE, Nouv. Ann. Mus. Hist. Nat. Paris 3 (1834) 346. — *Dryopteris hispidula* (DECNE) O. KTZE, Rev. Gen. Pl. 2 (1891) 813; C. CHR. Ind. Fil. (1905) 271, excl. syn. *Nephrodium angustifolium* PRESL & *N. smithianum* PRESL. — *Thelypteris hispidula* (DECNE) REED, Phytologia 17 (1968) 283. — Type: GUICHENOT, Timor (P). *Dryopteris contigua* ROSENST. Meded. Rijksherb. n. 31 (1917) 8; C. CHR. Gard. Bull. Str. Settl. 7 (1934) 244. — *Cyclosorus contigua* (ROSENST.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 243; HOLTUM, Rev. Fl. Mal. 2 (1955) 282, f. 163. — *Thelypteris contigua* (ROSENST.) REED, Phytologia 17 (1968) 269. — Type: TEUSCHER, Borneo (L).

*Dryopteris hirtopilosa* ROSENST. Meded. Rijksherb. n. 31 (1917) 7; M. G. PRICE, Kalikasan 2 (1973) 112. — *Thelypteris hirtopilosa* (ROSENST.) REED, Phytologia 17 (1968) 283. — Type: MERRILL 7671, Luzon (L; K).

*Dryopteris repandula* v.A.v.R. Nova Guinea 14 (1924) 20. — *Cyclosorus repandulus* (v.A.v.R.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 248; PANIGRAHI & MANTON, J. Linn. Soc. Bot. 55 (1958) 729–743. — *Thelypteris repandula* (v.A.v.R.) REED, Phytologia 17 (1968) 308. — Type: H. J. LAM 1058, W. New Guinea, Mamberamo River (BO; L).

*Dryopteris parasitica* var. *falcatula* CHRIST, Philip. J. Sci. 2 (1907) Bot. 197. — *Cyclosorus falcatulus* (CHRIST) COPEL. Fern Fl. Philip. (1960) 339. — *Thelypteris falcatula* (CHRIST) REED, Phytologia 17 (1968) 276. — Type: COPELAND 1677, Mindanao (MICH). — Fig. 20b–c.

*Caudex* erect; *stipe* 15–25 cm long bearing slender pale hairs, basal scales 7–10 mm long. *Lamina* 30–50 cm long, texture thin; pinnae 20–30 pairs, 2–4(–6) lower pairs gradually decrescent with dentate acroscopic auricles, lowest commonly 3 cm long. *Largest pinnae* 8–12 (–15) × 1.2–1.5 (–2.0) cm; base truncate with basal acroscopic lobe a little elongate; apex short-acuminate; edges lobed 3/4 towards costa, lobes slightly oblique; costules 3–4 mm apart; veins 7–9 pairs, lowest pair, at a wide angle to the costules, uniting to form a short excurrent vein to the sinus, next pair to margin; *lower surface* of rachis bearing rather sparse slender pale hairs 1–1.5 mm long, shorter hairs on costae, costules and veins, short slender hairs on surface between veins, some short capitate hairs usually present on costules and veins, no thick glandular hairs; *upper surface* of rachis and costae hairy as lower surface, scattered long hairs present on costules and veins, short capitate

hairs sometimes present between veins. *Sori* medial or a little supramedial; indusia thin, rather small, bearing hairs of varying length.

Distr. Tropical America and wetter parts of tropical Africa; Ceylon & S. India; Khasya Hills southwards to Malaya; throughout *Malesia*: Caroline Islands.

Ecol. Less common than *C. parasitica* and in more sheltered places, low altitudes to 1500 m.

Notes. Plants from Florida, Ascension Island, Ghana, Nigeria, Ceylon and Sarawak have proved to be diploid. For cytotoxic studies involving this species, see PANIGRAHI & MANTON 1955 (under *Cyclosorus repandulus*).

Only synonyms based on Malesian specimens are cited above; see HOLTUM 1976 for a fuller synonymy. The latest information on plants in tropical America is by A. R. SMITH, Univ. Cal. Publ. Bot. 59 (1971) 64, under the name *Thelypteris quadrangularis* (FÉE) SCHELPE. *Christella siamensis* (TAGAWA & K. IWATS.) HOLTUM, in Thailand and further north, differs only in less deeply lobed pinnae, and a distinction from *T. hispidula* seems doubtful; study of plants in cultivation is desirable.

**11. *Christella dentata* (FORSSK.) BROWNSEY & JERMY**, Brit. Fern Gaz. 10 (1973) 338; HOLTUM, Kew Bull. 31 (1976) 314. — *Polypodium dentatum* FORSSK. Fl. Aegypt. Arab. (1773) 185. — *Dryopteris dentata* (FORSSK.) C. CHR. Vid. Selsk. Skr. VIII, 6 (1920) 24; BACKER & POSTH. Varenfl. Java (1939) 58, excl. syn. *Aspidium parasiticum* & *A. patens*. — *Thelypteris dentata* (FORSSK.) E. ST. JOHN, Amer. Fern J. 26 (1936) 44. — *Cyclosorus dentatus* (FORSSK.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 8 (1938) 206; COPEL. Fern Fl. Philip. (1960) 337, p.p. — Type: FORSSKÄL, Arabia (C).

*Polypodium nymphale* G. FORST. Fl. Ins. Austr. Prodr. (1786) 81. — *Aspidium nymphale* (G. FORST.) SCHKUHR, Kr. Gew. 1 (1806) 36, t. 34; BLUME, En. Pl. Jav. (1828) 157. — *Thelypteris nymphalis* (G. FORST.) REED, Phytologia 17 (1968) 297. — *C. nymphalis* (G. FORST.) PICH SERMOLLI, Webbia 31 (1977) 252. — Type: G. FORSTER, New Zealand (BM).

*Polypodium molle* JACQ. Collect. Bot. 3 (1789) 188, non SCHREB. 1771. — *Aspidium molle* SW. in Schrad. J. Bot. 1800, 2 (1801) 34, nom. nov. — *Nephrodium molle* (SW.) R. BR. Prodr. Fl. N. Holl. (1810) 149; RACIB. Fl. Btzg 1 (1898) 188, p.p.? — *Dryopteris mollis* (SW.) Hieron. Hedwigia 46 (1907) 348; v.A.v.R. Handb. Suppl. (1917) 183, p.p.? — Type: Cult. Vienna (W).

*Dryopteris mindanaensis* CHRIST, Philip. J. Sci. 2 (1907) Bot. 194. — *Cyclosorus mindanaensis* (CHRIST) COPEL. Gen. Fil. (1947) 143; Fern Fl. Philip. (1960) 363. — *Thelypteris mindanaensis* (CHRIST) REED, Phytologia 17 (1968) 293. — Type: COPELAND 607, Mindanao (MICH).

*Dryopteris submolles* v.A.v.R. Bull. Jard. Bot. Btze III, 2 (1920) 152. — Type: LÖRZING 6040, Sumatra, Karo Plateau (BO; L).

*Cyclosorus subpubescens* sensu HOLTUM, Rev. Fl. Malaya 2 (1955) 273, f. 157. — Fig. 1p, 20a.

*Caudex* short-creeping; *stipe* very variable, to 50 cm long, short-hairy, basal scales c. 8 mm long. *Lamina* to 90 cm long; pinnae 15–25 pairs; lower 2–4 pairs of pinnae gradually decrescent, lowest commonly 4–5 cm long, sometimes less, all strongly auricled on the acroscopic base, the auricles lobed with forked veins in the lobes. *Largest pinnae* commonly 8–10 × 1.5–1.8 cm (largest seen 23 × 2.2 cm, type of *Dryopteris mindanaensis*); apex acuminate; edges lobed 1/2–2/3 towards costa, lobes slightly oblique with rounded tips; costules commonly 4 mm apart; veins 8–9 pairs, basal ones anastomosing with excurrent vein to the sinus, next acroscopic vein (basiscopic sometimes also) passing to side of the short sinus-membrane; *lower surface* of rachis bearing slender pale hairs 0.2–0.4 mm long, hairs on costae and costules mostly 0.2 mm long with some longer ones, rarely to 0.5 mm long, distally on pinnae short hairs present on surface between veins; hairs on *upper surface* of costae to 0.5 mm or more long, scattered similar hairs on costules and veins, very short hairs between veins. *Sori* medial apart from lowest ones which sometimes touch those on veins from neighbouring costules; *indusia* thin, copiously short-hairy.

Distr. Throughout tropics and subtropics of the Old World, since 1930 adventive in various places in the Americas.

Ecol. In open or lightly shaded places, at 0–1500 m.

Notes. For a fuller synonymy, see HOLTUM 1976. This is a very variable species which has greatly multiplied with the clearing of forest in the past 100 years. Plants examined from various sources have all been tetraploid; some experimental hybridization has been effected with *C. hispidula* (q.v.) and *C. parasitica*. It is probable that natural hybrids also occur; these are difficult to discriminate. Earlier authors did not distinguish between this species and its near allies, so that statements in literature are unreliable. Much more local study is needed.

**12. *Christella subpubescens* (BL.) HOLTUM**, Webbia 30 (1976) 193; Kew Bull. 31 (1976) 323. — *Aspidium subpubescens* BL. En. Pl. Jav. (1828) 149. — *Dryopteris subpubescens* (BL.) C. CHR. Gard. Bull. Str. Settl. 4 (1929) 390; BACKER & POSTH. Varenfl. Java (1939) 65. — *Thelypteris subpubescens* (BL.) K. IWATS. Mem. Coll. Sci. Univ. Kyoto B, 31 (1965) 173, excl. syn. *Aspidium jaculosum* CHRIST. — Type: BLUME, Java, river bank at Tanjong Krukot, Batavia (L, n. 910, 327–113, large sheet collection).

*Aspidium subpubescens* BL. var. *B*. BL. En. Pl.

Jav. (1828) 149. — Type: BLUME, Java, Noesa Kambangan (L, n. 922, 220–249, large sheet collection).

*Aspidium subpubescens* BL. var. *C* BL. l.c. — Type: BLUME, W. Java, Kollekot (L).

*Aspidium molle* var. *latipinna* BENTH. Fl. Hongkong. (1861) 455. — *Nephrodium latipinna* HOOK. Syn. Fil. (1867) 292. — *Dryopteris latipinna* (BENTH.) O. KTZE, Rev. Gen. Pl. 2 (1891) 813; v.A.v.R. Handb. (1908) 217. — *Cyclosorus latipinna* (BENTH.) TARD. Notul. Syst. 7 (1938) 73; HOLTUM, Rev. Fl. Malaya 2 (1955) 276, f. 159. — *Thelypteris latipinna* (BENTH.) K. IWATS. Acta Phytotax. Geobot. 21 (1865) 166; MORTON, Contr. U.S. Nat. Herb. 38 (1974) 361. — Lectotype (MORTON 1974): HANCE 135, Hong Kong (K).

*Dryopteris sumatrana* v.A.v.R. Handb. (1908) 227. — *Nephrodium molle* var. *major* BEDD. Handb. Suppl. (1892) 76, *quoad pl. Sumatranum*. — *Dryopteris subpubescens* var. *major* C. CHR. Gard. Bull. Str. Settl. 4 (1929) 390. — *Cyclosorus sumatranus* (v.A.v.R.) CHING, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 249; HOLTUM, Rev. Fl. Malaya 2 (1955) 275, f. 158. — *Thelypteris sumatrana* (v.A.v.R.) TAGAWA & K. IWATS. Acta Phytotax. Geobot. 22 (1967) 101. — Lectotype (HOLTUM 1955): C. MILLER s.n. 1778, Sumatra (BM).

*Dryopteris pseudoamboinensis* ROSENST. Meded. Rijksherb. n. 31 (1917) 7. — *Thelypteris pseudoamboinensis* (ROSENST.) PANIGRAHI, Phytologia 30 (1975) 410, pl. III. — Lectotype (PANIGRAHI 1975): KORTHALS 270, Sumatra (L).

*Dryopteris acuminata* ROSENST. Meded. Rijksherb. n. 31 (1917) 7, *non* WATTS 1916. — *Thelypteris blumei* PANIGRAHI, Phytologia 30 (1975) 409, *nom. nov.*; *op. cit.* 31 (1975) 369. — Type: ZOLLINGER 735, Java, Ufer des Tjidurians (L, n. 908, 333–35).

*Aspidium amboinense* sensu BL. En. Pl. Jav. (1828) 148; KUNZE, Bot. Zeit. 6 (1848) 261; METT. Farngett. IV (1858) 105. — *Nephrodium molle* var. *amboinense* BEDD. Handb. (1883) 278, *p.p.* — Fig. 20g.

*Caudex* short-creeping or suberect; *stipe* short, minutely hairy. *Lamina* varying much in size; several pairs of lower pinnae gradually decrescent, their acroscopic auricles rather small, entire or slightly crenate; largest pinnae lobed less than 1/2 towards costa (in small plants 1/4); in small plants at least 1½ pairs of veins anastomosing and the next pair ending beside the sinus-membrane, in large plants 2–2½ pairs of veins anastomosing to form a zig-zag excurrent vein and ½–1 pair ending beside the sinus-membrane; *lower surface* of rachis, costae and costules bearing minute hairs (0.1 mm long or less), in some specimens also orange glandular hairs on costules and veins, surfaces between veins minutely hairy, usually with some very short capitate hairs; *upper*

surface of costae bearing hairs c. 0.3 mm long, scattered longer hairs sometimes present on costules and veins, minute suberect hairs usually present between veins. *Sori* medial; indusia rather large, thin, glabrous or minutely hairy; in a few cases, capitate hairs present on sporangia.

Distr. N.E. India to S.W. China; Burma, Thailand, Vietnam; throughout *Malesia*; N. Queensland, New Hebrides, Fiji.

Ecol. On stream-banks in moderate shade in forest, also in lightly shaded places elsewhere, in lowlands.

Notes. It would be possible to make a key distinguishing the types of the basionyms above cited, but I find it impossible to fit all other specimens into such a key. More field study, and experimental study of cultivated plants, are needed.

The types of *Aspidium subpubescens* BL. var. *C* and *Nephrodium latipinna* HOOK., also the specimens of BLUME and ZOLLINGER on which the misinterpretations of the name *Aspidium amboinense* WILLD. were based, were small fertile plants. I have seen such plants on the banks of small streams in the forest in Pahang, where the streams are subject to periodic flooding with swiftly-flowing water after a sudden storm. In such places, plants are washed away before they attain their full size; a plant from the Tahan river in Malaya, grown at Kew, is much larger than any on the river banks, and is very like BLUME's var. *B*, though less rigid in texture. Plants found growing spontaneously in and near the Botanic Garden in Singapore (also others growing similarly at Bogor) are very like the type of *A. subpubescens* BL. and differ from the fully-grown plants of stream-bank origin in having somewhat broader pinnae. I have no evidence that the Singapore and Bogor plants are fertile from an early age, and think that they are probably genetically different from stream-bank plants, but I cannot point to clear distinctions.

Thick orange glandular hairs are present on the lower surface of pinnae of most of the stream-bank plants from Malaya, and of the Java plants named *amboinense* by BLUME, KUNZE, METTENIUS and HOOKER. Such glands are absent from the type of *Nephrodium latipinna* HOOK. and other specimens from Hong Kong, also from the type of *A. subpubescens* BL. and similar specimens from Singapore and Bogor. But other specimens very similar to typical *A. subpubescens* have a few such glandular hairs, while on the other hand some stream-bank plants from northern Malaya are quite glandless like the type of *N. latipinna* from Hong Kong.

Some stream-bank plants from Malaya, also from Luzon, have small capitate hairs on some of their sporangia; I have not observed this character in any other specimens of *Christella*. The capitate hairs appear to be just like those on the lower surface of pinnae between veins.

**13. *Christella subdentata* HOLTUM.** Kew Bull. 31 (1976) 335. — Type: VILLAFLORES 57, Mindoro, Lubang Island (MICH).

*Caudex* short, erect or suberect; *stipe* 25 cm long, minutely hairy, basal scales c.  $10 \times 1$  mm. *Lamina* 50 cm long; pinnae 15 pairs; lowest 1–2 pairs of pinnae somewhat reduced (basal pinnae 5 cm long), not auricled on the acroscopic side. *Largest pinnae*  $9.5 \times 1.5$  cm; base truncate; apex acuminate with cauda 2 cm long; edges lobed 2/5 towards costa; costules 3.5 mm apart; veins to 8 pairs, lowest pair anastomosing, second acroscopic veins passing to side of sinus-membrane; lower surface of rachis, costae and costules bearing hairs 0.1 mm long, similar hairs present between veins; upper surface of rachis covered with hairs 0.5 mm long, shorter hairs present on costae, sparse minute hairs between veins. *Sori* medial; indusia short-hairy.

Distr. *Malesia*: Philippines (Mindoro), only known from the type.

Note. This may be a hybrid.

**14. *Christella timorensis* HOLTUM.** Kew Bull. 31 (1976) 316. — Type: BLOEMBERGEN 3364, Timor, Mt Timan (L; BO, K).

*Caudex* long-creeping, 5 mm diameter, bearing fronds 2–3 cm apart; *stipe* short-hairy, basal scales c.  $6 \times 1.5$  mm, rigid. *Lamina* of type incomplete, probably 70 cm or more long with pinnae more than 20 pairs; 4–5 pairs of lower pinnae decrescent, with enlarged entire basal acroscopic lobes (to 2.0 cm long), lowest pinna seen 7.5 cm long. *Largest pinnae* 15 cm long, 2.2 cm wide above base; apex narrowly acuminate but not caudate; edges lobed 3/5–2/3 towards costa; lobes oblique, a little falcate, broadly pointed; costules 4.5–5 mm apart; veins to 12 pairs, basal 1–1½ pairs anastomosing, next acroscopic vein, or next pair, passing to side of sinus-membrane; lower surface of rachis bearing rather sparse hairs 0.7–1.0 mm long, costal hairs erect, to 0.7 mm, shorter hairs on costules and veins, sometimes also a few thick glandular hairs, slender erect hairs present between veins; hairs on upper surface of costae to 0.5 mm long, similar hairs scattered on costules and veins, no hairs between veins. *Sori* supramedial; indusia with short stiff hairs.

Distr. *Malesia*: Lesser Sunda Is. (Timor), only known from type.

Ecol. In grassland along stream at 1300 m.

**15. *Christella parasitica* (L.) LÉV.** Fl. Kouytchéou (1915) 475; HOLTUM, Kew Bull. 31 (1976) 309. — *Polypodium parasiticum* L. Sp. Pl. (1753) 1090. — *Dryopteris parasitica* (L.) O. KTZE, Rev. Gen. Pl. 2 (1891) 811; C. CHR. Ark. Bot. 9, n. 11 (1910) 26, f. 4. — *Cyclosorus parasiticus* (L.) FARW. Amer. Midl. Nat. 12 (1929) 259; HOLTUM, Rev. Fl. Malaya 2 (1955) 281, f. 162. — *Thelypteris parasitica* (L.) K. IWATS. Mem. Coll.

Sci. Univ. Kyoto B, 31 (1965) 172. — Type: OSBECK, Canton (S-PA in Herb. Swartz).

*Aspidium procurrens* METT. Ann. Mus. Bot. Lugd.-Bat. 1 (1864) 231. — *Dryopteris procurrens* (METT.) O. Ktze, Rev. Gen. Pl. 2 (1891) 813; v.A.v.R. Handb. (1908) 211, 819, p.p. — *Cyclosorus procurrens* (METT.) COPEL. Fern Fl. Philip. (1960) 340, *nomen tantum*. — *Thelypteris procurrens* (METT.) REED, Phytologia 17 (1968) 306. — Type: ZIPPELIUS, Java (L, n. 908, 335–152).

*Nephrodium didymosorum* PARISH ex BEDD. Ferns Br. India (1866) t. 200. — *N. molle* var. *didymosorum* BEDD. Handb. (1883) 279. — *Dryopteris didymosora* (BEDD.) C. CHR. Ind. Fil. (1905) 262; v.A.v.R. Handb. (1908) 225. — Type: PARISH, Burma, Moulmein (not found in Herb. Bedd. at K).

*Nephrodium tectum* BEDD. Handb. Suppl. (1892) 79, excl. KING 8757. — Lectotype (HOLT-TUM 1976): WALLICH 394, Singapore (K-W).

*Dryopteris albociliata* COPEL. J. Arn. Arb. 10 (1929) 177. — *Thelypteris albociliata* (COPEL.) REED, Phytologia 17 (1968) 259. — Type: BRASS 566, E. New Guinea, Basiatibu (GH; UC).

*Cyclosorus benguetensis* COPEL. Philip. J. Sci. 81 (1952) 28; Fern Fl. Philip. (1960) 341. — *Thelypteris benguetensis* (COPEL.) REED, Phytologia 17 (1968) 263. — Type: MERRILL 7679, Luzon, Benguet Subprov. (MICH) — Fig. 20f.

*Caudex* short- to long-creeping; *stipe* to 40 cm long, copiously hairy. *Lamina* to 40 cm long, texture thin; pinnae c. 20 pairs, closely placed; basal pinnae (as dried for herbaria) deflexed, not widely spaced, not or little reduced, auricled at the acroscopic base, auricle curved towards the rachis, sometimes dentate. *Largest pinnae* commonly 16×2 cm, short-acuminate, lobed 2/3–3/4 towards costa, lobes slightly oblique; costules c. 4 mm apart; veins 8–10 pairs, basal pair anastomosing, next pair passing to margin above base of sinus or sometimes the second acroscopic vein touching the sinus-membrane; *lower surface* typically covered with slender erect hairs to 1 mm long, thick orange glandular hairs usually present on veins in the lobes; hairs on *upper surface* of costae thicker than on lower, similar hairs scattered on costules and veins, very short hairs between veins. *Sori* medial, lower ones divergent; indusia hairy.

*Distr.* Wetter parts of tropics and subtropics of Asia; throughout Malesia; Queensland; in the Pacific to Tahiti and Hawaii; E. Africa (Uganda, Kenya); St Helena (introduced?).

*Ecol.* In open places, mainly at low altitudes but also to 1500 m; apparently nowhere abundant.

*Notes.* The type was discovered by CHRISTENSEN (1910); previously the name was used confusedly. In Kwangtung (source of the type) almost all plants have a rather short-creeping caudex and many glandular hairs on veins, but some have a longer rhizomatous caudex and few

or no glands. The type of *Aspidium procurrens* METT. lacks glands. BEDDOME at first used the name *procurrens* for a mixture of species which had in common a creeping rhizome; v.A.v.R. also used the name confusedly. Under *Cyclosorus procurrens* COPELAND described a fern with narrow pinnae lobed half-way to the costa; I have not seen specimens. Some specimens have the frond-form of this species but short hairs; some agree in hairs and glands but have some reduced basal pinnae (type of *Cyclosorus benguetensis*); some such specimens are probably hybrids. MANTON found that *C. parasitica* in Ceylon is tetraploid and her co-workers produced hybrids with the diploid *C. hispidula* and with other tetraploids. In breeding, the absence of glandular hairs is recessive to their presence.

**16. *Christella acuminata*** (HOULT.) LÉV. Fl. Kouy-tchéou (1915) 476; HOLTUM, Kew Bull. 31 (1976) 333. — *Polypodium acuminatum* HOUTT. Nat. Hist. 14 (1783) 181, pl. 99, f. 2. — *Thelypteris acuminata* (HOUTT.) MORTON, Amer. Fern J. 48 (1958) 139; K. IWATS. Mem. Coll. Sci. Univ. Kyoto B, 31 (1965) 186. — Type: THUNBERG, Japan (UPS).

*Polypodium unittum* THUNB. Fl. Jap. (1784) 336, non LINN. — *Polypodium sophoroides* THUNB. Tr. Linn. Soc. 2 (1794) 341, *nom. nov.* — *Nephrodium sophoroides* (THUNB.) DESV. Mém. Soc. Linn. Paris 6 (1827) 256; BAK. Syn. Fil. (1867) 289. — Type: as for *P. acuminatum* HOUTT.

*Caudex* long-creeping, slender; *stipe* 25 cm or more long, sparsely hairy. *Lamina* to 60 cm long, texture firm; lower pinnae more widely spaced than the rest but not or little reduced. *Largest pinnae* to 9×1.5 cm (fertile), 15×2 cm (sterile), lobed a little less than half-way to costa; lobes acute, basal acroscopic lobe enlarged, ± curved towards the rachis, with some forked veins; costules 3.5–4.5 mm apart; veins commonly 7 pairs (to 10), pale and prominent on both surfaces, basal pair anastomosing, next pair ending beside sinus-membrane; *lower surface* of costae and costules bearing a variable number of short erect hairs and a few longer ones, sparse short hairs present on and between veins, glandular hairs lacking; *upper surface* of costae bearing hairs to 0.5 mm long, similar hairs often scattered on costules and veins, a variable number of very short hairs between veins. *Sori* medial or a little supramedial; indusia large, copiously short-hairy.

*Distr.* Southern China and southern Japan, in Malesia: Philippines (Babuyan Is. and N. Luzon).

*Notes.* For a fuller synonymy, see CHING 1938 and IWATSUKI 1965. The specific epithet *sophoroides* is used in most of the older literature. In general aspect this species is similar to *C. arida* but lacks reduced basal pinnae and glandular hairs; the larger pinnae of *C. acuminata* are also rather strongly auricled.

## ADDENDA, CORRIGENDA ET EMENDANDA

As has been done in Series I, Flowering Plants, it seems useful to complete the volume with worthwhile additions and corrections.

Page numbers are provided with either *a* or *b* denoting the left and right columns respectively.

### Gleicheniaceae

- 13b *Gleichenia volubilis* var. *peninsularis*.  
Replace by the following:  
7a. *Gleichenia gigantea* WALL. ex HOOK.  
Spec. Fil. 2 (1844) 5, t. 3A; BEDD. Ferns  
Brit. India (1865) t. 30. — *Diplopterygium*  
*giganteum* (HOOK.) NAKAI, Bull. Nat. Sci.  
Mus. Tokyo n. 29 (1950) 50. — Type:  
WALLICH 157, Nepal (K).

*G. glauca* auct. non (THUNB.) HOOK.;  
BEDD. Handb. (1883) 2, *quoad pl. Ind.*

Differs from *G. volubilis* JUNGH. of Java  
and Sumatra as follows: lower surface of  
lamina distinctly glaucous; stipular leaflets  
branched and more deeply lobed; scales on  
lower surface of rachis and costae rusty  
brown like the felt of stellate hairs.

Distr. N.E. India at c. 1500 m; Vietnam;  
N. Thailand; in *Malesia* still only known  
from the collection cited from the Malay  
Peninsula.

Note. Apart from the copious scales  
and hairs on rachis and costae this differs  
little from *G. longissima* BL. Further field  
study on the higher mountains of Malaya is  
desirable.

- 14a *Gleichenia clemensiae* (COPEL.) HOLT-  
TUM.

Add the following: Stipular leaflets lacking  
(thus resembling *G. bullata*, p. 13).

- 20a *Gleichenia reflexipinnula* C. CHR.  
Add the following: BRASS 30382 from Mt  
Wilhelm, 2900 m, has ultimate branches to  
42 by 4.5 cm with costules 5 mm apart and  
veins distinctly prominent.

- 20b *Gleichenia truncata* (WILLD.) SPR. var.  
*truncata*.

Add the following synonym: *G. bifurcata*  
BL. En. Pl. Jav. (1828) 250.

- 22a *Gleichenia milnei* BAKER.

Add the following synonym: *Sticherus*  
*kajewskii* ST JOHN, Occ. Pap. Bishop Mus.  
17 (1942) 81.

Add to Distr.: Mindanao (OLSEN 986).

- 22b Insert the following after *Gleichenia*  
*erecta*:

25a. *Gleichenia hooglandii* HOLTUM,  
Blumea 14 (1967) 327. — Type:  
HOOGLAND & SCHODDE 7692, W. High-  
lands of Papua New Guinea (CANB).

Intermediate between *G. erecta* and *G.*  
*bolanica* (p. 24). Differs from *G. erecta* as  
follows: largest lamina-segments on the  
ultimate branches 8–15 mm long, costules  
3–4 mm apart.

- 34a *Dicranopteris linearis* (BURM. f.) UNDERW.

var. *ferruginea* (BL.) HOLTUM.

Correction for synonymy: The com-  
bination *D. ferruginea* was first published  
by HOSOKAWA, Trans. Nat. Hist. Soc.  
Formosa 25 (1935) 435. Additional  
synonym: *D. tomentosa* COPEL. Univ.  
Cal. Publ. Bot. 18 (1942) 217. — Type:  
CLEMENS 41228, N.E. New Guinea (UC).

- 34a *Dicranopteris linearis* var. *subferruginea*  
(HIERON.) NAKAI.

Add the following synonym: *Gleichenia*  
*caudata* COPEL. Bishop Mus. Bull. 59  
(1929) 9. — Type: GILLESPIE 4389, Fiji  
(UC).

- 35a *Dicranopteris linearis* var. *subpectinata*  
(CHRIST) HOLTUM.

Add to Distr.: Palawan.

- 36 Additional varieties of *Dicranopteris*  
*linearis* which need study:

var. *bidentata* v.A.v.R. Bull. Jard. Bot.  
Btzig III, 5 (1922) 204, Karimon I.

var. *crassifrons* v.A.v.R. *Ibid.*, Ternate.

var. *stipulosa* CHRIST, Bull. Herb. Boiss.  
II, 6 (1906) 1010, Luzon.

### Schizaeaceae

- 37 *Schizaeaceae*: Fossils.

Add the following: JENNINGS & EGGERT,  
Amer. J. Bot. 59 (1972) 66 state that the  
anatomy of *Senftenbergia* is like that of  
*Ankyropteris* and conclude that *Senften-*  
*bergia* is not related to *Schizaeaceae*. But the  
sporangia and spores of *Senftenbergia*  
are very similar to those of some living  
*Schizaeaceae*; the latter are certainly much  
reduced and specialized vegetatively. The  
subject needs a much more comprehensive  
study.

- 39 Cytology of *Lygodium*.

Add the following: *L. longifolium* from  
Singapore: n = 58, tetraploid; *L. salici-*  
*folium* from Perak: n = 28?, diploid. (In-  
formation from I. MANTON, in litt.).

- 40 *Schizaea* SM.

Add the generic synonym: *Ripidium*  
BERNH. in Schrader, J. Bot. 1800, pt 2  
(1801) 127.

- 44b *Schizaea malaccana* BAK. var. *robustior*  
C. CHR.

Add the synonym: *S. robusta* BAK. Syn.  
Fil. (1868) 429. — Type: HILLEBRAND,  
Hawaii (K).

- 44 *Lygodium* SWARTZ.

Delete the generic synonym *Ripidium*  
BERNH.

- 53b *Lygodium flexuosum* (L.) Sw.  
Add the synonym: *Ugena polymorpha*  
CAV. Icones 6 (1801) 75, t. 595, f. 1.
- 59a *Lygodium longifolium* (WILLD.) Sw.  
Add to Distr.: Palawan.
- 61b *Lygodium versteegii* CHRIST.  
Add to Distr.: Philippines: Mindanao,  
Luzon.

## Isoetaceae

- 63 *Isoetes* LINNÉ.  
See revision of the genus in New Guinea  
by J. R. CROFT, Blumea 26 (1980) 177–190,  
with key, description of new species *I.*  
*hopei* and *I. stevensii*, and under *I. neo-*  
*guineensis* BAKER a new variety *rheo-*  
*phila*; also SEM photographs of spores of  
all species and much new information on  
vegetative morphology and distribution.
- 64 *Isoetes* sp. has been found in Central West  
Sumatra, in addition to Mindanao and New  
Guinea the third island where the genus is  
hitherto discovered in Malesia. Cf. Fl.  
Males. Bull. 30 (1977) 2767 and J. R.  
FLENLEY & R. J. MORLEY, J. Biogeogr. 5  
(1978) 57–58. It is assumed to be an un-  
described species, differing from the Philip-  
pine one in the megaspores. The exact local-  
ity is on the westside of Mt Kerintji, midway  
the lakes Sati and Landak Panjang, at c.  
2080 m altitude, in small, shallow, muddy  
depressions in swampy forest, 1°42'S and  
101°11'E.

## Cyatheaceae

- 71 Conspectus of the family Cyatheaceae: new  
comments:  
I would now raise the subfamilies to the  
rank of family, but see no reason for other  
changes. PICHI SERMOLLI (Webbia 31,  
1977, 333–334, 423–427) includes all in the  
order *Dicksoniales*, with suborders and  
families thus:  
*Thyrsopteridineae*: *Thyrsopteridaceae*  
(*Thyrsopteris*).  
*Culcitineae*: *Culcitaceae* (*Culcita*).  
*Dicksoniineae*: *Dicksoniaceae* (including  
*Cibotium* and *Cystodium*), *Lophosoriaceae*  
(*Lophosoria*).  
*Cyatheineae*: *Cyatheaceae* (*Sphaeropteris*,  
*Alsophila*, *Nephelea*, *Trichopteris*, *Cyathea*,  
*Cnemidaria*).  
*Metaxyineae*: *Metaxyaceae* (*Metaxya*).  
Subdivision of the genus *Cyathea*: recent  
proposals:  
R. M. TRYON (Contr. Gray Herb. 200, 1970,  
1–53) has recognized *Sphaeropteris*  
BERNH. as a distinct genus, in which he  
includes the tropical American species

mentioned on p. 124 of the present work,  
and also several others which disagree in  
scales and sori from the specification on p.  
65; in my opinion the latter should be  
excluded. TRYON limits the genus *Cyathea*  
to some tropical American species, dis-  
tinguishing them from all Malesian species  
here included in *Cyathea* subg. *Cyathea*  
solely on the lack of a seta at the apex of  
stipe-scales. He has transferred all  
Malesian species of *Cyathea* subg. *Cyathea*  
sensu HOLTUM 1963 to the genus *Alsophila*  
(type species *A. australis* R. BR.).

I agree that subg. *Sphaeropteris* as  
defined on p. 76 is clearly distinct from all  
other members of the family, but I cannot  
agree that the remaining species, including  
those of tropical America, are divisible into  
natural groups on such clearly defined  
characters. CONANT has shown that  
hybrids exist between species of different  
genera as recognized by TRYON, and in  
one case such hybrids have good spores  
(*Rhodora* 77, 1975, 441–455).

All species so far examined, of several  
different genera as recognized by TRYON  
(including *Sphaeropteris*) have the  
chromosome number 69. This is a very  
strong indication that *Cyathea* in the broad  
sense adopted in Flora Malesiana is a phy-  
letic unity, and I adhere to my recognition  
of it as a single genus. As *Sphaeropteris* is  
the only sub-group separable on well-  
defined characters, I still place all the rest  
in a subgenus *Cyathea*, the further sub-  
division of which seems to me still un-  
certain. The species *C. australis* (R. BR.)  
DOMIN (type of *Alsophila*) has spores  
which differ considerably from those of the  
majority of Malesian species transferred to  
*Alsophila* by TRYON (see GASTONY,  
Amer. J. Bot. 63, 1976, 754, f. 110 and  
compare with figures of Malesian species  
on p. 751).

Taxonomy of Malesian species of *Cyathea*:  
Since 1963 many new collections have been  
made, especially in New Guinea. I have not  
been able to examine all of these. The  
following data are based on specimens  
which have come to my attention; probably  
more new species remain to be recognized,  
and new information about many species  
remains unrecorded.

- 80 In Key to the species, after lead 77, add:  
77a. Pinnules to 22 mm long, bearing free  
tertiary leaflets.
- 69a. *C. nothofagorum*  
77a. Pinnules to at least 50 mm long, lack-  
ing free tertiary leaflets.
- 82b *Cyathea hunsteiniana* BRAUSE.  
Add to description: Scales on pinna-rachis

- elongate, thin, dull brown with a few marginal setae (WOMERSLEY & VANDENBERG 37293, Western Highlands, 1500 m).
- 101a *Cyathea oosora* HOLTUM.  
Add to Distr.: Pulau Tioman (KLU 19781). The Celebes specimens here included should probably rank as a distinct species; more material is needed.
- 103b Insert additional species:
- 69a. *Cyathea nothofagorum* HOLTUM, Blumea 14 (1966) 327. — Type: PULLEN 5358, N.E. New Guinea, W. Highlands, Kubur Range, in *Nothofagus* forest at 2775 m (K).  
Aspect of *C. microphyloides* and *C. perpelvigera* (p. 82), having small fronds and pinnate pinnules, differing in (large) hemitelioid indusia and lack of hairs on lower surface of pinna-rachis and costae, also in scales not bullate.
- 118b *Cyathea biformis* (ROSENST.) COPEL.  
Add the following: PULLEN 7295 from the Upper Fly River at 100 m has 1–2 pairs on small pinnae (the pinnules of which do not have an incised lamina) near the base of stipes, and unusually large pinnules; sterile pinnules to 9 by 2 cm, fertile to 10 by 1.2 cm.
- 121b *Cyathea lurida* (BL.) COPEL.  
Add the following: A sterile specimen from a low altitude on limestone near Kuala Lumpur (J. BOEY 4, KLU) closely resembles this species but differs in pale brown stipe and rachis. Typical *C. lurida* occurs only on high mountain ridges.
- 130b *Cyathea sangirensis* (CHRIST) COPEL.  
Reduce to a synonym of the following:  
*Cyathea felina* (ROXB.) MORTON, Contr. U.S. Nat. Herb. 38 (1974) 344. — *Polypodium felinum* ROXB. Calc. J. Nat. Hist. 4 (1844) 496. — Lectotype: from Amboina (G); others at BR and in Herb. J.E. Smith.
- 135a *Cyathea angiensis* (GEPP) DOMIN.  
Add the following note: Stipes always spiny, length of spines 2–7 mm.
- 138 Key to the species of subsection *Fourniera*: alter as follows:
7. Scales absent from lower surface of veins.  
8. Spines on stipe scattered, 1–3 mm long; soral scales many, covering sorus to maturity . . . . . 150. *C. tripinnata*  
8. Spines on stipe copious, to 5 mm long; soral scales not covering sorus at maturity . . . . . 150a. *C. jacobsii*
- 140b *Cyathea tripinnata* COPEL.  
Delete synonym *C. arachnoidea* (non HOOK.) BACKER & POSTH.
- 140b After *Cyathea tripinnata*, insert the following:  
150a. *Cyathea jacobsii* HOLTUM, Reinwardtia 8 (1974) 499. — Type: M. JACOBS 8113, S. Sumatra at 1200–1300 m (L).
- This species, occurring in South Sumatra and West Java, differs from *C. tripinnata* in the characters shown in the above modified key; it also has a different distribution. Specimens named *C. arachnoidea* in W. Java by BACKER & POSTHUMUS (see above) belong to *C. jacobsii*. In Key to the species of subsection *Schizocaena*, lead 13: alter the word 'pinnules' at end of line 2 from bottom to 'segments'.
- 154 *Cyathea rosenstockii* BRAUSE.  
Add the following: NAKAIKE 717, Central District, Papua, Wotape, 1500 m, has flat pale scales to 4 mm long and dark glossy thick hairs on lower surface of pinna-rachis; costal scales narrow, pale with dark bullate bases, smaller distally; on costules very few small scales.
- 166a *Cibotium barometz* (L.) J. SM.  
Add to Distr.: N.E. New Guinea (B. S. PARRIS in Fern Gaz. 11, 1979, 428).
- 167 *Culcita* PRESL.  
Correction in Cytol.: *C. macrocarpa* n = 66; *C. villosa* 2n = 232 (tetraploid with base number 58); from unpublished observations by G. VIDA on plants in cultivation at Kew.
- Lindsaea-group (KRAMER)**
- 182a *Sphenomeris biflora* (KAULFUSS) TAGAWA.  
Mapped in Pac. Pl. Areas 3 (1975) 344–345.
- 182b *Sphenomeris chinensis* (L.) MAXON.  
Mapped in Pac. Pl. Areas 3 (1975) 346–347.
- 186a *Tapeinidium denhamii* (HOOKER) C. CHR.  
Mapped in Pac. Pl. Areas 3 (1975) 348–349.
- 204b *Lindsaea bouillodii* CHRIST.  
For this species MORTON (Contr. U.S. Nat. Herb. 38, 1974, 385) made the new combination *Lindsaea interrupta* (ROXB.) MORTON, based on *Vittaria interrupta* ROXBURGH, referring *L. cambodgensis* CHRIST to its synonymy (following my earlier misinterpretation of this name: KRAMER, Blumea 15, 1967, 563). In view of the gross incompleteness of ROXBURGH's original description, and of the complete lack of indication of provenance on the label of the specimen regarded as type by MORTON, I think it unwise to adopt ROXBURGH's (and MORTON's) names which I prefer to regard as names of uncertain application. The same holds in my opinion for the interpretation of *Vittaria lunulata* ROXBURGH, despite MORTON's assertions to the contrary (l.c. 386).
- 214a *Lindsaea tetragona* KRAMER.  
This East Malesian-Pacific species, mapped in Pac. Pl. Areas 3 (1975) 340, was

- recently collected as far west as the Nicobar Is. (Great Nicobar), and may thus be expected in western Malesia, too.
- 214b *Lindsaea polyclena* KRAMER.  
Mapped in Pac. Pl. Areas 3 (1975) 340–341.
- 216a *Lindsaea tenuifolia* BLUME.  
Mapped in Pac. Pl. Areas 3 (1975) 340–341.
- 229a *Lindsaea adiantoides* J. SMITH.  
Mapped in Pac. Pl. Areas 3 (1975) 342–343.
- 230a *Lindsaea gueriniana* (GAUD.) DESVAUX.  
Mapped in Pac. Pl. Areas 3 (1975) 332–333.  
For the record from Fiji see BROWNLIE, Pterid. Fl. Fiji (1977) 134.
- 237 *Lindsaea repens* (BORY) THWAITES, with varieties.  
Mapped in Pac. Pl. Areas 3 (1975) 336–337.
- 241b *Lindsaea carvifolia* KRAMER.  
This was placed in *sect. Odontoloma* of *subg. Odontoloma*. Its occurrence in Celebes was reported with a ?. A good series of specimens from that island (HENNIPMAN c.s. 5264, L) confirms its presence; furthermore, it shows that simply pinnate as well as bipinnate leaves occur side by side, and that the species should be transferred to *sect. Lindsaenium*, where it must be placed between *L. rosenstockii* BRAUSE and *L. versteegii* (CHRIST) v.A.v.R. In appearance and width of the pinnule segments it is more like the latter but differs in less divergent and usually spatulately broadened segments. It is undoubtedly distinct from both; the simply pinnate leaves are indistinguishable from specimens previously examined. The distinction between *sect. Odontoloma* and *sect. Lindsaenium* may require reconsideration.
- 245a *Lindsaea rigida* J. SMITH.  
Mapped in Pac. Pl. Areas 3 (1975) 334–335; for the record from Fiji see BROWNLIE, Pterid. Fl. Fiji (1977) 139.
- 245b *Lindsaea sarawakensis* KRAMER.  
This was described from a single, incomplete collection and was only provisionally placed next to *L. rigida*. Two additional collections from Sarawak, NIELSEN 815 (AAU) and JERMY 14334 (BM, Z), both from Mt Mulu, confirm the taxonomic position assigned to it and provide additional data. The rhizome anatomy and morphology agree with that of *Lindsaea subg. Odontoloma sect. Lindsaenium*, and the difference from *L. rigida*, as given in the key (p. 203), proves to be constant. Further additional data: petiole to c. 35 cm long; rhizome 1–1.5 mm diam., long-creeping, castaneous; scales very much like those of *L. rigida*. Fertile pinnae always with a short apical sorus only.



## ADDENDA, CORRIGENDA ET EMENDANDA 2

- 81 At couplet 101 in key delete '94, *C. incisoserrata*', and insert afterwards:  
 101a. Apex of stipe-scales setiform; bullate scales on costules dull brown, smooth

94. *C. incisoserrata*  
 101a. Apex of stipe-scales not setiform; bullate scales on costules almost white, clathrate. 94a. *C. decurrens*

113a After 94. *C. incisoserrata*, insert:  
 94a. *Cyathea decurrens* (HOOK.) COPEL. Univ. Cal. Publ. Bot. 14 (1929) 356; HOLTUM, Blumea 12 (1964) 248.—*Alsophila decurrens* HOOK. Spec. Fil. 1 (1844) 51.—Type: NIGHTINGALE s.n., Pacific (K).  
 Stipe-scales broad, castaneous with broad paler margins, apex broadly rounded or ± attenuate, not setiform; pinnules-lobes oblique, almost all free but decurrent, all deeply lobulate; costules covered beneath with almost white clathrate bullate scales; indusia very small, hidden by sporangia.  
 Distr. Solomon Is., New Hebrides, Fiji, Samoa, Cook I.; in Malesia: New Ireland.  
 Note. Collected in New Ireland at 2300 m (CROFT 301); on other islands found at much lower altitudes. CROFT's specimen differs from others in its firmer bullate scales and in lacking the thick white hairs which are usually ± abundant on the lower surface of costae in this species; it may represent a distinct variety. *C. decurrens* and allied Pacific species have stipe-scales like those of the Neotropic species to which TRYON limits the genus *Cyathea*; no other known Paletropic species have this character.

265 *Teratophyllum* METT. ex KUHN.  
 Add to Distr.: Ceylon.

266 *Teratophyllum*, section *Teratophyllum*.  
 Add to Distr.: Ceylon.

269b *Teratophyllum aculeatum* (BL.) METT. ex KUHN.  
 Add to Distr.: Ceylon; rare, first collected by THWAITES, recently recollected in Sinharaja Forest, KOSTERMANS 27853, Oct. 1979 (L).

325a-326b *Hennipman* has reduced some taxa which I regard as species, notably *B. simplicifolia* (HOLTUM) CHING, *B. malaccensis* (C. CHR.) CHING and *B. nitens* HOLTUM. See my paper on Malayan *Bolbitis*, Mal. Nat. J. 33 (1980) 79–82 for an alternative opinion.

361b *Coryphopteris gymnopoda* (BAK.) HOLTUM var. *bintangensis* HOLTUM.  
 Add to the description: The type has many such hairs but recent collections by A. G. PIGGOTT on Gunong Ulu Kali (Genting Highlands) at 1830 m show much variation. Specimens from Borneo are all quite glabrous between veins.

393b Line 7 from bottom: *Dryopteris penangiana* (HOOK.) C. CHR. was based on *Polypodium penangianum* HOOK. The type of this was a WALLICH specimen which bore the locality Penang, but the species is otherwise only known from northern India, so I am sure it was wrongly localized. I did not know anything about this species when I wrote my book on Malayan ferns.

452a *Dryopteris perakensis* was based on *Aspidium perakense* BEDD., a species I could not account for and omitted from my book on Malayan ferns. I could not find a type in Kew herbarium, but some years later it was found, among other BEDDOME specimens, in the basement. It is based on an immature plant of *Sphaerostephanos polycarpus* mixed with a small fragment of a fertile pinna from another plant, an aberrant *Christella*. VAN ALDERWERELT VAN ROSENBURGH of course misinterpreted it.

494b *Sphaerostephanos mutabilis* (BRAUSE) HOLTUM. Add:  
 Note. This is near *S. aquatilis* (no. 44), differing in narrower pinnae, veins free, and lower surface quite glabrous; the two should perhaps be united.

502b *Sphaerostephanos invisus* (FORST. f.) HOLTUM.  
 Add to Ecol.: less commonly to 1000 m.



# INDEX TO SCIENTIFIC PLANT NAMES

compiled by

M. J. VAN STEENIS-KRUSEMAN

*Epithets or taxa above generic rank* have been entered under their name.

*Infrageneric epithets* have been entered immediately under the generic name to which they belong, preceded by the indication of their rank (subgenera, sections, etc.). If possible sections are arranged under the subgenera to which they belong.

Epithets of *wrongly identified species* precede the correct ones.

*Intraspecific epithets* have been entered under the specific name to which they belong, preceded by the indication of their rank (subspecies, varieties, formas, etc.).

*Epithets of new names and new combinations* have been printed in **bold type**, *synonyms in italics*.

An asterisk behind a page number denotes the presence of an illustration of the concerned taxon; 'map' printed behind a page number denotes that a map of the concerned taxon is present on that page.

Page numbers in **bold type** denote main treatment.

Some minor printing errors in plant names have been corrected.

Of synonyms with a double authority, the latter has not always been cited in full. The full authority can easily be derived from the text.

Scientific plant names mentioned in the Dedication have not been indexed.

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